

PRICE \$1.00



**Assembling
and Using Your...**

Heathkit

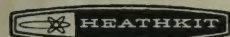
**CAPACITOR
CHECKER**
MODEL IT-11

HEATH COMPANY

A Subsidiary of Daystrom Inc.

BENTON HARBOR, MICHIGAN

Assembly
and
Operation
of the



**CAPACITOR
CHECKER**
Model IT-11

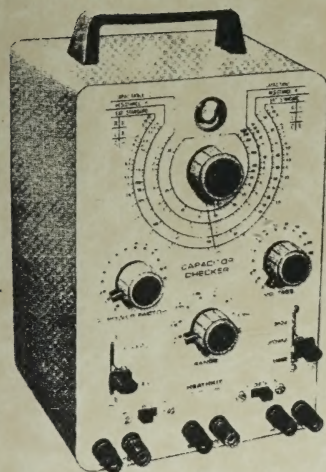
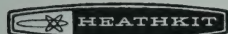


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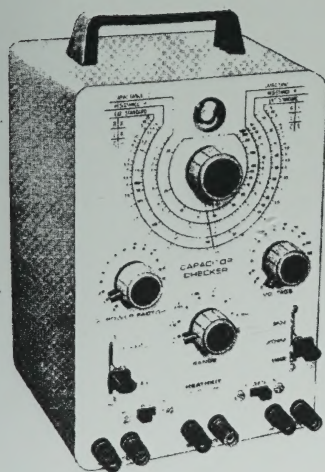
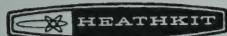


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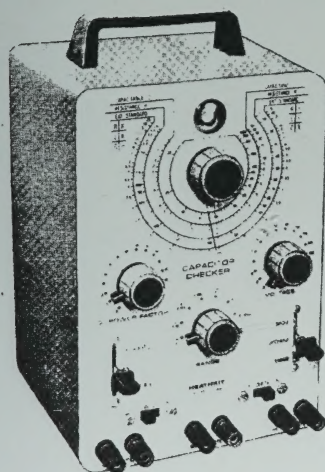
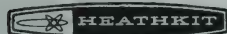


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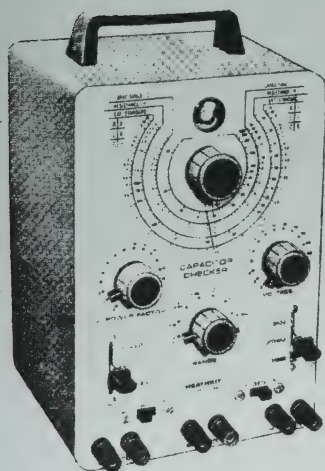


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SPECIFICATIONS

Test Circuit	AC bridge, powered by an internal 60 cycle supply or by an external audio generator with 10 volts output, Upper frequency limit: 10 kc.
Capacitance, 5 Ranges	10 μ f to .005 μ f. .001 μ f to .5 μ f. .1 μ f to 50 μ f. 20 μ f to 1000 μ f. External standard (comparison bridge; maximum ratio 25:1).
Capacitor Leakage	DC test voltages from 3 to 600 volts in 18 steps.
Resistance, 4 Ranges	5 Ω to 5000 Ω . 500 Ω to 500 K Ω . 50 K Ω to 50 megohms. External standard (comparison bridge; maximum ratio 25:1).
Inductance Check	External standard only.
Power Supply	Transformer-operated, half-wave rectifier.
Power Requirements	105-125 volts AC, 50/60 cycles, 30 watts.
Dimensions	9-5/8" high x 6-5/8" wide x 5" deep.
Net Weight	5 lbs.
Shipping Weight	7 lbs.

INTRODUCTION

The **HEATHKIT** Model FT-11 Capacitor Checker is a general-purpose instrument designed for use by servicemen, engineers, and technicians in checking capacitors for value, leakage, shorts, and opens. The Checker may also be used to check resistance, inductance, and transformer turns ratios.

A bridge circuit and eye tube indicator are used

in making quick, accurate tests. Precision resistors and capacitors in the bridge circuit provide a high degree of accuracy and stability.

Terminals are provided on the front panel for the component under test (TEST), an external generator (EXT. GEN.) and external standards (EXT. STD.).

CIRCUIT DESCRIPTION

ent reference to the small schematic diagrams in this description will prove helpful in understanding how the circuit functions.

heart of the Capacitor Checker is the AC-bridge. Balance control R13 is used to the resistance of two arms of the bridge. third arm is the standard (internal or external) and the fourth arm is the component tested.

GE RATIO CALCULATIONS

ring to Figure 1, assume that $R_x = R_s$ (value) and that Balance control R13 is in center of its range so that $R13A = R13B$ (Ω each). Under this condition, with the bridge balanced and with R_x equal to R_s , the of $R13A$ to $R13B = 1:1$.

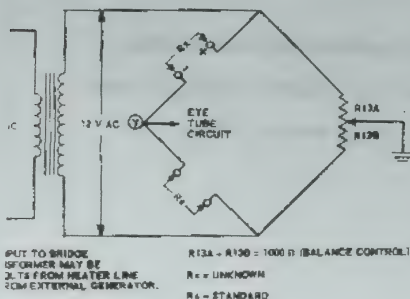


Figure 1

R_x did not equal R_s , balance of the bridge would occur with the Balance control at some point other than the center of its range. When balance occurs with $R13A = 600 \Omega$, then $R13B = 400 \Omega$. The ratio is now $600/400$, or $1.5:1$.

When balance occurs with $R13A = 800 \Omega$, then $R13B = 200 \Omega$. The ratio is $800/200$, or $4:1$.

Turning the Balance control changes the values of $R13A$ and $R13B$. When the bridge is balanced, $A \text{ times } R_s = R13B \text{ times } R_x$. Then the value at Y (see Figure 1) is minimum and the eye tube opens. The bridge circuit is basically the same for all types of measurements; when the standards and the unknown values change,

MEASURING RESISTANCE

When checking resistance, R_s becomes the resistance standard and R_x is the unknown resistance. The value of R_x is indicated on the front panel by the Balance control pointer when the bridge is balanced.

MEASURING CAPACITANCE

LOWER RANGES - $C \times .0001$ and $C \times .01$

Referring to Figure 2, the standard, C_s , is a capacitor (internal or external), and C_x is the unknown capacitance being measured. As in measuring resistance, the Balance control is adjusted for balance of the bridge. At balance $R13A \text{ times } X_{Cs} = R13B \text{ times } X_{Cx}$. In this case, X_{Cs} is the capacitive reactance of C_s and X_{Cx} is the capacitive reactance of C_x .

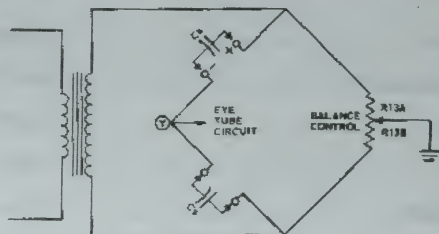


Figure 2

HIGHER RANGES - $C \times 1$ and $C \text{ EXT Scale}$

Capacitors are measured on the higher ranges just as described for the two lower ranges, except for electrolytics.

Since electrolytic capacitors have a certain amount of internal series resistance, it is necessary to use POWER FACTOR control R14 along with Balance control R13 to properly balance the bridge. See Figures 3 and 3A. The POWER FACTOR control is used to cancel the effect of series resistance in electrolytic capacitor C_x , and is used only on the two higher ranges. The formula for finding the series resistance of an electrolytic capacitor is:

$$\text{Series Resistance} = \frac{Q \text{ PF}}{2\pi FC}$$

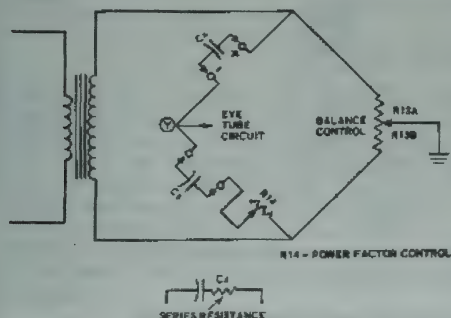


Figure 3

% PF = percent power factor

$$\pi = 3.14$$

F = frequency of applied voltage

C = capacity in farads

For example, the series resistance of a 2 μ f capacitor with 5% PF at 60 cycles would equal:

$$\frac{.05}{2\pi \times 60 \times 2 \times .000001} = 66.3 \Omega$$

NOTE: The POWER FACTOR control is calibrated, using internal 2 μ f capacitor C6 as a standard, at 60 cps. Therefore, when using an external generator at a frequency other than 60 cps, the value indicated by the POWER FACTOR control must be corrected by a factor of $\frac{FT}{60}$. FT is the external applied frequency.

EXAMPLE: Determine the % PF of a capacitor which measures 5% PF at 120 cps.

$$\% \text{ PF} = \text{measured \% PF} \times \frac{FT}{60}$$

$$\% \text{ PF} = .05 \times \frac{120}{60}$$

$$\% \text{ PF} = 10\%$$

USING THE EXTENDED SCALE

The capacitance scale is extended by adding 9000 Ω resistor R34 in series with Balance control R13. The bridge is balanced as before, using the Balance control, plus the POWER FACTOR control for electrolytics. However,

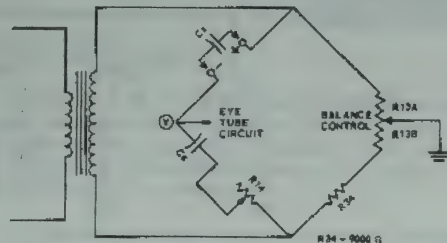


Figure 4

the ratio has now been changed due to the addition of R34. With the Balance control in the center of its range, R13A = 500 Ω and R13B = 500 Ω . Therefore, the ratio is:

$$\frac{9000 \text{ plus } 500}{500} = 19:1$$

The standard internal capacitance value is 2 μ f, which makes the center scale reading equal to 19 times 2 μ f, or 38 μ f. The remainder of the "C" EXTENDED SCALE is calculated in the same way.

MEASURING INDUCTANCE

Again, the bridge is balanced using Balance control R13. At balance, R13A times XLs = R13B times XLx. Here XLs = the inductive reactance of the standard, and XLx = the inductive reactance of the component being tested. An external standard must be used when measuring inductance.

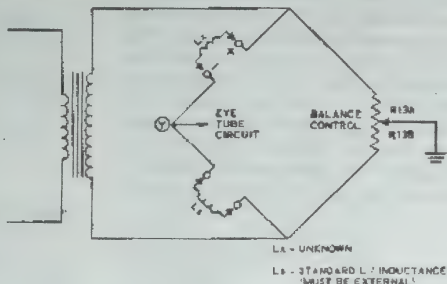
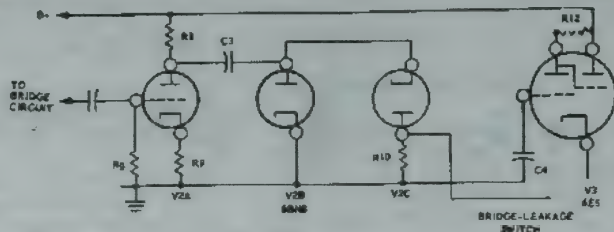


Figure 5

The AC series resistance (characteristic) of the external component should be similar to that of the test component to permit balancing, as the POWER FACTOR control is not used in the external standard circuit.

Figure 6



YE TUBE CIRCUIT

When the bridge circuit is not balanced, an AC signal voltage is applied from point Y of the bridge to the grid of amplifier stage V2A. The amplified signal from V2A is then applied to the voltage-doubler rectifier circuit, consisting of V2B, V2C, C3, and C4. The resulting negative DC voltage is applied to the grid of the eye tube V3, closing the eye.

When the bridge is balanced, no signal is applied from the bridge to V2A. Therefore, no negative DC voltage is present at the grid of the eye tube, and the eye stays open.

CAPACITOR LEAKAGE

CHECKING LEAKAGE

When checking a capacitor for leakage, V2A is connected as a DC amplifier. When voltage is applied to the capacitor under test, through 10 Ω limiting resistor R40, the capacitor charges, drawing current through grid resistor Rg of V2A. The voltage drop across this resistor causes V2A to conduct due to a positive voltage developed on its grid. This changes the voltage at the plate of V2A and at the grid of the eye tube, causing the eye to close. When the capacitor is fully charged, current ceases to flow through grid resistor Rg, and the grid voltage of V2A returns to its original value. The plate voltage of V2A also returns to

its original value and the eye tube opens. This indicates a good capacitor.

If the capacitor being checked is leaky or shorted, current continues to flow through grid resistor Rg, preventing the eye tube from opening.

LEAKAGE DISCHARGE

When the BRIDGE-LEAKAGE switch is moved from the LEAKAGE position to the DISCHARGE position, the capacitor under test is shunted to ground through resistors R40 and R36. During the resulting discharge time, a voltage is again developed at the grid of amplifier stage V2A. In turn, V2A causes a change in the grid voltage of eye tube V3, causing the eye to close. After the capacitor has discharged, the voltage on the grid of tube V2A returns to its original value and the eye tube opens.

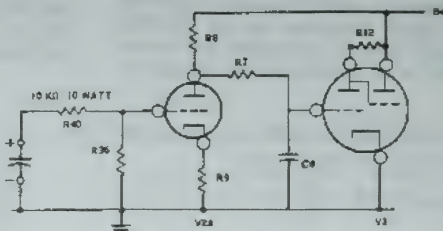
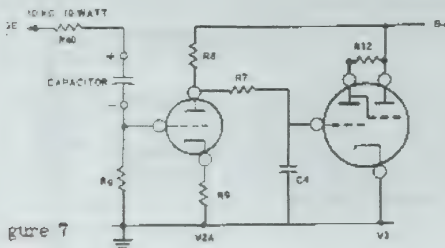


Figure 8

POWER SUPPLY

The transformer-operated power supply uses V1 in a half-wave rectifier circuit. The fused primary circuit of the transformer is symmetrically bypassed with C9 and C10 for increased accuracy when measuring low capacitance at 60 cps. The filament circuit is effectively center tapped with resistors R41 and R42. Capacitors C1 and C2, with resistors R1, R2, R3, R4, and R5 make up a filter-voltage divider network to provide proper DC voltages to the circuit.

Figure 7



CONSTRUCTION NOTES

This manual is supplied to assist you in every way to complete your kit with the least possible chance for error. The arrangement shown is the result of extensive experimentation and trial. If followed carefully, the result will be a stable instrument, operating at a high degree of dependability. We suggest that you retain the manual in your files for future reference, both in the use of the instrument and for its maintenance.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. Refer to the charts and other information on the inside covers of the manual to help you identify the components. If some shortage or parts damage is found in checking the Parts List, please read the Replacement section and supply the information called for therein. Include all inspection slips in your letter to us.

In order to expedite delivery to you, we are occasionally forced to make a minor substitution of parts. Such substitutions are carefully checked before they are approved and parts supplied will work satisfactorily. In checking the Parts List for resistors, for example, you may find that a resistor with a 5% tolerance has been

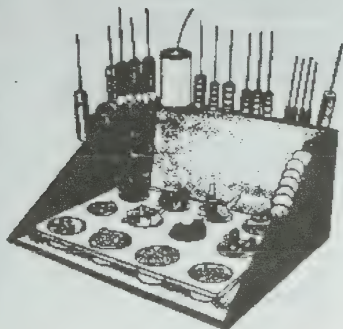
substituted for a resistor with a 10% tolerance, as shown in the Parts List. These changes are self-evident and are mentioned here only to prevent confusion in checking the contents of your kit.

Resistors generally have a tolerance rating of 10% unless otherwise stated in the Parts List. Tolerances on capacitors are generally even greater. Limits of +100% and -20% are common for electrolytic capacitors.

We suggest that you do the following before work is started:

1. Lay out all parts so that they are readily available.
2. Provide yourself with good quality tools. Basic tool requirements consist of a screwdriver with a 1/4" blade; a small screwdriver with a 1/8" blade; long-nose pliers; wire cutters, preferably separate diagonal cutters; a pen knife or a tool for stripping insulation from wires; a soldering iron (or gun) and rosin core solder. A set of nut drivers and a nut starter, while not necessary, will aid extensively in construction of the kit.

Most kit builders find it helpful to separate the various parts into convenient categories. Muffin tins or molded egg cartons make convenient trays for small parts. Resistors and capacitors may be placed with their lead ends inserted in the edge of a piece of corrugated cardboard until they are needed. Values can be written on the cardboard next to each component. The illustration shows one method that may be used.



PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
<u>Resistors</u>		
1-3	4	100 Ω 1/2 watt (brown-black-brown)
1-119	2	560 Ω 1/2 watt (green-blue-brown)
1-7	2	680 Ω 1/2 watt (blue-gray-brown)
1-8	1	820 Ω 1/2 watt (gray-red-brown)
1-9	1	1000 Ω 1/2 watt (brown-black-red)
1-44	1	2200 Ω 1/2 watt (red-red-red)
1-16	1	4700 Ω 1/2 watt (yellow-violet-red)
1-19	1	6800 Ω 1/2 watt (blue-gray-red)
1-20	10	10 K Ω 1/2 watt (brown-black-orange)
1-69	1	18 K Ω 1/2 watt (brown-gray-orange)
1-25	1	47 K Ω 1/2 watt (yellow-violet-orange)
1-29	2	220 K Ω 1/2 watt (red-red-yellow)
1-35	1	1 megohm 1/2 watt (brown-black-green)
1-36	1	1.5 megohm 1/2 watt (brown-green-green)
2-83	2	200 Ω 1/2 watt 1% precision
2-35	1	9000 Ω 1/2 watt 1% precision
2-38	1	20 K Ω 1/2 watt 1% precision
2-55	1	2 megohm 1/2 watt 1% precision
1A-5	1	22 K Ω 1 watt (red-red-orange)
1B-18	1	33 K Ω 2 watt (orange-orange-orange)
1B-10	4	47 K Ω 2 watt (yellow-violet-orange)
3J-7	1	10 K Ω 10 watt wire-wound
<u>Capacitors</u>		
20-2	1	200 μ f molded mica (red-black-brown)
21-71	2	.001 μ f disc ceramic 1400 V
21-81	1	.1 μ f disc ceramic
23-70	1	.02 μ f tubular 2% (two matched .01 μ f capacitors connected in parallel)

PART No.	PARTS Per Kit	DESCRIPTION
<u>Capacitors (Cont'd.)</u>		
23-59	1	.05 μ f tubular
23-55	1	.5 μ f tubular
23-16	1	2 μ f tubular
25-41	2	40 μ f 350 V electrolytic
<u>Controls-Switches</u>		
11-40	2	1000 Ω control wire-wound
60-1	1	SPST slide switch
60-2	1	DPDT slide switch
62-15	1	3-position lever switch
62-16	1	3-position lever switch
63-277	1	16-position rotary switch
63-278	1	8-position rotary switch
<u>Tubes-Transformers</u>		
411-128	1	6BN8 tube
411-120	1	6E5 tube
411-158	1	6AX4 tube
51-80	1	Bridge transformer
54-34	1	Power transformer
<u>Connectors-Terminal Strips-Sockets</u>		
100-M16B	3	Binding post cap, black
100-M16R	3	Binding post cap, red
427-3	6	Binding post base
431-1	1	Dual-lug terminal strip
431-10	1	3-lug terminal strip
431-11	2	5-lug terminal strip
431-16	1	2-lug terminal strip
434-31	1	Octal socket
434-12	1	6-pin tube socket
434-77	1	9-pin tube socket
<u>Metal Parts-Knobs-Pointers</u>		
90-175	1	Cabinet
200-M302	1	Chassis
203-250F511-512-513	1	Front panel
462-97	2	Knob, lever switch
462-139	3	Knob, control
462-140	1	Knob, large control
463-27	3	Small pointer
463-28	1	Dial pointer
<u>Hardware</u>		
250-2	2	3-48 x 5/16" screw
250-16	2	6-32 x 3/8" screw
250-26	4	6-32 x 5/8" screw
250-48	4	6-32 x 1/2" screw



PART No.	PARTS Per Kit	DESCRIPTION
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Hardware (Cont'd.)

250-89	17	6-32 x 3/8" screw
250-83	2	#10 sheet metal screw
252-1	2	3-48 nut
252-3	21	6-32 nut
252-4	2	8-32 nut
252-7	4	Control nut
252-22	2	Speednut
253-9	4	#8 flat washer
253-10	4	Control flat washer
254-7	2	#3 lockwasher
254-1	20	#6 lockwasher
254-2	1	#8 lockwasher
254-5	2	Small control lockwasher
254-4	2	Control lockwasher
255-1	1	1/8" spacer
255-13	4	1/4" spacer
259-1	6	#8 solder lug

PART No.	PARTS Per Kit	DESCRIPTION
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Hardware (Cont'd.)

259-2	1	#8 solder lug
208-2	2	Mounting clip
Insulators-Wire		
73-1	4	Grommet
75-17	12	Binding post insulator
75-24	1	Line cord strain relief
89-1	1	Line cord
134-38	1	Wire harness
344-1	1	Length hookup wire

Miscellaneous

211-15	1	Handle
261-9	4	Rubber feet
421-20	2	1/2 ampere slow-blow fuse (1 spare)
422-1	1	Fuse holder
595-445	1	Manual

PROPER SOLDERING TECHNIQUES

Only a small percentage of HEATHKIT equipment purchasers find it necessary to return an instrument for factory service. Of these instruments, by far the largest portion of malfunctions are due to poor or improper soldering.

If terminals are bright and clean and free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Correctly soldered connections are essential if the performance engineered into a kit is to be fully realized. If you are a beginner with no experience in soldering, a half hour's practice with some odd lengths of wire may be a worthwhile investment.

For most wiring, a 30 to 100 watt iron or its equivalent in a soldering gun is very satisfactory. A lower wattage iron than this may not heat the connection enough to flow the solder smoothly over the joint. Keep the iron tip clean and bright by wiping it from time to time with a cloth.

CHASSIS WIRING AND SOLDERING

1. Unless otherwise indicated, all wire used is the type with colored insulation (hookup wire); the size of the conductor is the same for all colors of hookup wires furnished with this kit. In preparing a length of hookup wire, 1/4" of insulation should be removed from each end unless directed otherwise in the construction step.
2. To avoid breaking internal connections when stripping insulation from the leads of transformers or similar components, care should be taken not to pull directly on the lead. Instead, hold the lead with pliers while it is being stripped.
3. Leads on resistors, capacitors and similar components are generally much longer than they need to be to make the required connections. In these cases, the leads should be

cut to proper length before the part is added to the chassis. In general, the leads should be just long enough to reach their terminating points.

Crimp or bend the lead (or leads) around the terminal to form a good joint without relying on solder for physical strength. If the wire is too large to allow bending or if the step states that the wire is not to be crimped, position the wire so that a good solder connection can still be made.

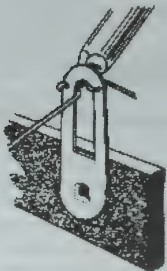
Position the work, if possible, so that gravity will help to keep the solder where you want it.

Place a flat side of the soldering iron tip against the joint to be soldered until it is heated sufficiently to melt the solder.

7. Then place the solder against the heated terminal and it will immediately flow over the joint; use only enough solder to thoroughly wet the junction. It is usually not necessary to fill the entire hole in the terminal with solder.

8. Remove the solder and then the iron from the completed junction. Use care not to move the leads until the solder is solidified.

A poor or cold solder joint will usually look crystalline and have a grainy texture, or the solder will stand up in a blob and will not have adhered to the joint. Such joints should be reheated until the solder flows smoothly over the entire junction. In some cases, it may be necessary to add a little more solder to achieve a smooth bright appearance.



CRIMP WIRES

HEAT CONNECTION

APPLY SOLDER

ALLOW SOLDER
TO FLOW

PROPER SOLDER
CONNECTION

NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT A NEW ROLL PLAINLY MARKED "ROSIN CORE RADIO SOLDER" BE PURCHASED.

STEP-BY-STEP PROCEDURE

The following instructions are presented in a logical step-by-step sequence to enable you to complete your kit with the least possible confusion. Be sure to read each step all the way through before beginning the specified operation. Also read several steps ahead of the actual step being performed. This will familiarize you with the relationship of the subsequent operations. When the step is completed, check it off in the space provided. This is particularly important as it may prevent errors or omissions, especially if your work is interrupted. Some kit builders have also found it helpful to mark each lead in colored pencil on the Pictorial as it is added.

The fold-out diagrams in this manual may be removed and attached to the wall above your working area; but, because they are an integral part of the instructions, they should be returned to the manual after the kit is completed.

In general, the illustrations in this manual correspond to the actual configuration of the kit; however, in some instances the illustra-

tions may be slightly distorted to facilitate clearly showing all of the parts.

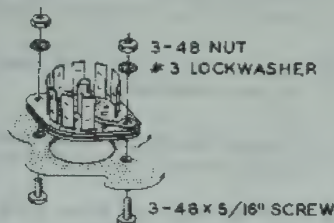
The abbreviation "NS" indicates that a connection should not be soldered yet as other wires will be added. When the last wire is installed, the terminal should be soldered and the abbreviation "S" is used to indicate this. Note that a number will appear after each solder instruction. This number indicates the number of leads that are supposed to be connected to the terminal in point before it is soldered. For example, if the instruction reads, "Connect a lead to lug 1 (S-2)," it will be understood that there will be two leads connected to the terminal at the time it is soldered. (In cases where a lead passes through a terminal or lug and then connects to another point, it will count as two leads, one entering and one leaving the terminal.)

The steps directing the installation of resistors include color codes to help identify the parts. Also, if a part is identified by a letter-number designation on the Schematic, its designation will appear in the construction step which directs its installation.

CHASSIS PARTS MOUNTING

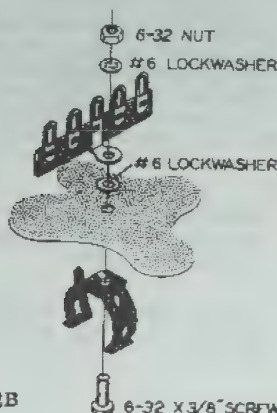
Refer to Pictorial 2 (fold-out from Page 10) for the following steps.

- () Install four rubber grommets in chassis holes A, B, C, and H.
- () Install a speednut at each square cut-out on the rear of the chassis. Make sure the flat side of each speednut faces outward.
- () Mount the 9-pin tube socket at V2. Use 3-48 screws, #3 lockwashers, and 3-48 nuts as shown in Detail 2A. Orient the blank space as shown in Pictorial 2.



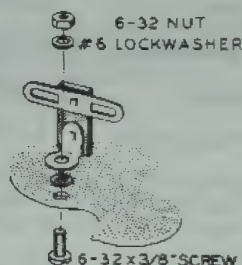
Detail 2A

- () In the same manner, mount the octal tube socket at V1. Use 6-32 x 3/8 inch screws, #6 lockwashers, and 6-32 nuts. Position the socket with its keyway as shown.
- () Referring to Detail 2B, mount the capacitor mounting clip and a 5-lug terminal strip at location F. Use a 6-32 x 3/8 inch screw, two #6 lockwashers, and a 6-32 nut.



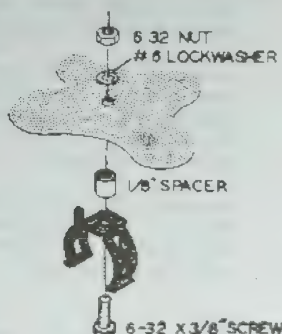
Detail 2B

- () Mount a dual-lug terminal strip at L. Use a 6-32 x 3/8 inch screw, #6 lockwashers, and 6-32 nut as shown in Detail 2C.



Detail 2C

- () Similarly, mount a 2-lug terminal strip at K.
- () Mount 3-lug terminal strip J on the rear flange of the chassis. Use a 6-32 x 3/8 inch screw, two #6 lockwashers and a 6-32 nut.
- () Mount fuse holder M, using a 6-32 x 3/8 inch screw, #6 lockwasher, and 6-32 nut.
- () Mount the eye tube mounting clip as shown in Detail 2D. Use a 6-32 x 3/8 inch screw, 1/8 inch spacer, #6 lockwasher, and 6-32 nut.

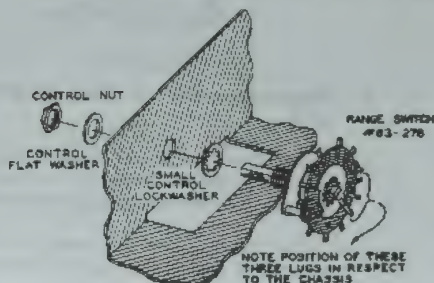


Detail 2D

- () Mount 5-lug terminal strip G, using a 6-32 x 3/8 inch screw, #6 lockwashers, and 6-32 nut. Make sure the terminal strip is mounted on the screw nearest grommet H as shown in Pictorial 2.

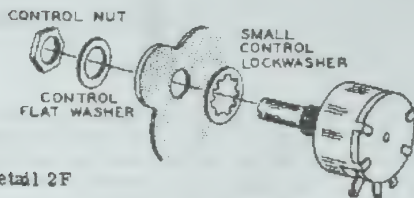
Cut the leads of the bridge transformer (#51-80) to the following lengths:

COLOR	LENGTH
() Red	5-1/4"
() Red-yellow	3-1/4"
() Black	2-1/2"
() Black-yellow	2-1/2"
() Strip 1/4" of insulation from the end of each lead and tin. ("Tin" means to melt a small amount of solder on the exposed lead end.)	



Detail 2E

- () Mount the bridge transformer (#51-80), using 6-32 x 3/8" screws, #6 lockwashers, and 6-32 nuts. Insert the red lead through grommet A to be connected later.
- () Mount the RANGE switch (#63-278) at P. Use a small control lockwasher, a flat washer, and control nut as shown in Detail 2E. Position this switch with its lugs as shown in Pictorial 2.
- () Similarly, mount the Balance control (#11-40) at N. Use a small control lockwasher, a flat washer, and control nut. Position as shown in Pictorial 2.



Detail 2F

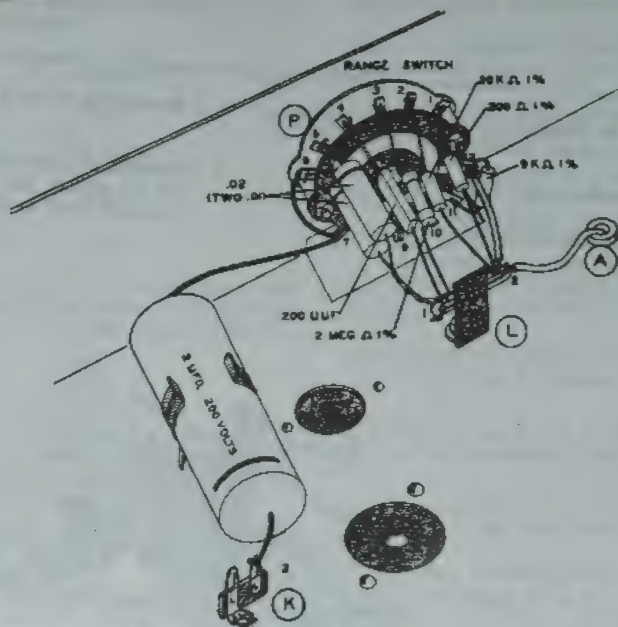
HARNESS AND RANGE SWITCH P WIRING

Refer to Pictorials 3 (fold-out from Page 10) and 4 for the following steps.

- () Locate the wire harness and form it as shown in Pictorial 3.
- () Install the harness on the chassis as shown. Except for the green-white, brown-white, and orange-white wires from breakout #4, and the yellow-white and green wires from breakout #2, all the wires from these two breakouts go through the chassis as shown, on either side of the RANGE switch.
- () Connect the green-white wire from breakout #4 to lug 8 of switch P (S-1).
- () Connect the green wire from breakout #2 to lug 9 of switch P (S-1).
- () Connect the yellow-white wire from breakout #2 to lug 10 of switch P (S-1).

Connect the following three wires from breakout #5 to terminal strip F,

- () Brown wire to lug 1 (NS).
- () Gray wire to lug 3 (NS).
- () Black-white wire to lug 4 (NS).
- () Position the violet and red wires as shown in Pictorial 3 and insert their ends through grommet H.
- () Install the 6-pin tube socket on the 6E5 eye tube. Now place the tube into the eye tube mounting clip as shown in Pictorial 4. Position lugs 1 and 6 of the tube socket just above grommet H. The front end of the eye tube should be flush with the front flange of the chassis.
- () Referring to Pictorial 4, connect the red wire coming through grommet H to lug 3 of tube socket V3 (NS).
- () Connect the violet wire coming through grommet H to lug 5 of tube socket V3 (S-1).



Pictorial 5

RANGE SWITCH P WIRING

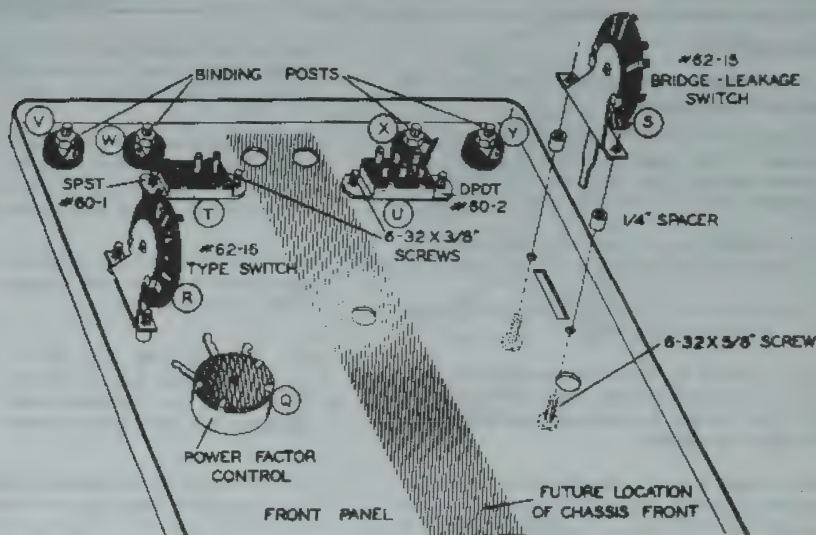
Refer to Pictorial 5 for the following steps.

- () C6. Insert the 2 μ f 200 V capacitor into the capacitor clip as shown. Connect the lead from the banded end to lug 2 of terminal strip K (NS).
- () Insert the free lead through lug 7 (NS) to lug 6 (S-1) of switch P. Position this lead so that it clears the switch frame. Now solder lug 7 (S-2).
- () R34. Connect a 9000 Ω (9 K Ω) precision resistor from lug 11 (S-1) to lug 12 (NS) of switch P. Position the resistor as shown.
- () Connect a 1-1/2" wire from lug 12 of switch P (S-2) to lug 2 of terminal strip L (NS).
- () R31. Connect a 200 Ω precision resistor from lug 1 of switch P (S-1) to lug 2 of terminal strip L (NS).
- () R32. Connect a 20 K Ω precision resistor from lug 2 of switch P (S-1) to lug 2 of terminal strip L (NS).
- () Connect the red lead from the bridge transformer coming through grommet A, to lug 2 of terminal strip L (S-5).
- () R33. Connect a 2 megohm precision resistor from lug 3 of switch P (S-1) to lug 1 of terminal strip L (NS).
- () C7. Connect a 200 μ f (red-black-brown) molded mica capacitor from lug 4 of switch P (S-1) to lug 1 of terminal strip L (NS).
- () C8. Connect the .02 μ f tubular capacitor from lug 5 of switch P (S-1) to lug 1 of terminal strip L (S-3). (C8 is actually two .01 μ f capacitors connected in parallel.)

CHASSIS WIRING

Refer to Pictorial 6 (fold-out from Page 19) for the following steps.

- () Connect a 6-1/2" wire to lug 2 of terminal strip F (NS). Insert the other end of this wire through hole E (near lug 8 of tube socket V2). It will be connected later.
 - () C3. Connect a .05 μ fd capacitor from lug 2 (NS) to lug 7 (NS) of tube socket V2.
 - () Connect a 1-1/2" wire from lug 2 (S-2) to lug 6 (S-1) of tube socket V2.
 - () R7. Connect a 100 Ω (brown-black-brown) 1/2 watt resistor from lug 7 of tube socket V2 (NS) to lug 1 of terminal strip F (S-2). Position as shown.
 - () R6. Connect a 1.5 megohm (brown-green-green) 1/2 watt resistor from lug 8 of tube socket V2 (NS) to lug 2 of terminal strip F (S-2).
 - () R9. Connect a 680 Ω (blue-gray-brown) 1/2 watt resistor from lug 9 of tube socket V2 (S-1) to lug 3 of terminal strip F (NS).
 - () R10. Pass one lead of a 220 K Ω (red-red-yellow) 1/2 watt resistor through lug 1 of tube socket V2 (NS) to lug 4 of terminal strip F (S-2). Now solder lug 1 of V2 (S-2). Connect the other lead to lug 3 of terminal strip F (NS).
 - () Connect a 5" wire to lug 3 of tube socket V1 (NS). Position this wire beside terminal strip F. The other end will be connected later.
 - () Connect a 7" wire to lug 5 of terminal strip F (NS). Position this wire as shown and insert the other end through grommet H. It will be connected later.
- NOTE: The purpose of using twisted pairs of hookup wire is to provide cancellation of hum in the filament wiring. Best results will be obtained if the wires are twisted approximately two full turns per inch.
- () Twist together two 3-1/2" lengths of hookup wire. At one end of this twisted pair, connect either wire to lug 4 (NS) and the other wire to lug 5 (NS) of tube socket V2.
 - () At the other end of this twisted pair, connect either wire to lug 7 (NS) and the other wire to lug 8 of tube socket V1 (NS).
 - () Twist together two 10" lengths of hookup wire. At one end of this twisted pair, connect either wire to lug 7 (NS) and the other wire to lug 8 (NS) of tube socket V1.
 - () Position this pair as shown in Pictorial 6 and insert the other end through grommet H to be connected later.
 - () C1. Connect a 40 μ fd, 350 V electrolytic capacitor from lug 3 of tube socket V1 (NS) to lug 5 of terminal strip G (NS). The positive (+) lead goes to tube socket V1.
 - () R1. Connect a 47 K Ω (yellow-violet-orange) 2 watt resistor from lug 4 of terminal strip G (NS) to lug 3 of tube socket V1 (NS).
 - () R2. Connect another 47 K Ω (yellow-violet-orange) 2 watt resistor between the same two lugs, lug 4 of terminal strip G (NS) and lug 3 of tube socket V1 (S-4). Position as shown.
 - () R3. Connect a 47 K Ω (yellow-violet-orange) 2 watt resistor from lug 5 of terminal strip F (NS) to lug 4 of terminal strip G (NS).
 - () R4. Connect another 47 K Ω (yellow-violet-orange) 2 watt resistor between the same two lugs, lug 5 of terminal strip F (NS) and lug 4 of terminal strip G (S-4).
 - () R5. Connect a 33 K Ω (orange-orange-orange) 2 watt resistor from lug 5 of terminal strip F (NS) to lug 3 of terminal strip G (S-1). Position as shown.
 - () C2. Connect a 40 μ fd, 350 V electrolytic capacitor from lug 3 of terminal strip F (NS) to lug 1 of terminal strip G (NS). The positive (+) lead goes to terminal strip G.
 - () Connect a 3" wire between lug 1 (S-2) and lug 5 (S-2) of terminal strip G. Position as shown.

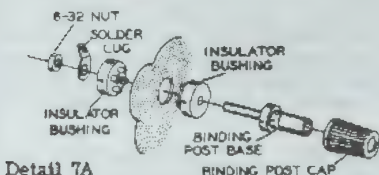


Pictorial 7

FRONT PANEL ASSEMBLY

Refer to Pictorial 7 for the following steps.

- () Mount the SPST slide switch (#60-1) at T, using 6-32 x 3/8" screws. Position this switch as shown.
- () In the same manner, mount the DPDT slide switch (#60-2) at U.
- () Mount binding post bases at V, W, X and Y as shown in Detail 7A. Position each solder lug as shown in Pictorial 7. The hole in each binding post base should be parallel to the bottom of the panel. Do not install binding post bases in the EXT. GEN. locations at this time.

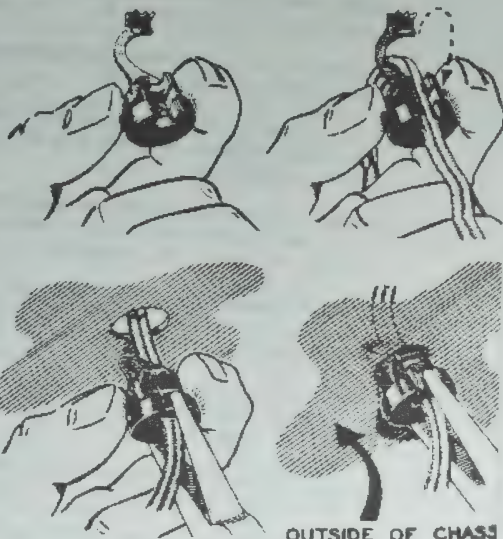


Detail 7A

- () Mount the BRIDGE-LEAKAGE switch (#62-15) at S. Use 6-32 x 5/8" screws, 1/4" spacers, and position as shown.
- () Similarly, mount the Type switch (#62-16) at R. Position as shown.
- () Mount the POWER FACTOR control (#11-40) at Q. Use a control lockwasher, flat washer, and control nut as shown in Detail 2F. Position as shown in Pictorial 7.
- () Remove the control nut and flat washer from control N and switch P. Mount the front panel on the chassis. Do not pinch any of the harness wires. Now reinstall the flat washer and control nut on control N and switch P. Do not tighten yet.
- () Mount the two remaining binding post bases at AA and BB. Position the hole in each binding post base parallel to the bottom of the front panel. Position the solder lugs as shown in Pictorial 8.
- () Now tighten the control nut on control N and switch P.

Refer to Pictorial 8 for the following steps.

- () Connect either wire of the twisted pair coming through grommet H to lug 1 of tube socket V3 (S-1). Position as shown.
- () Connect the other wire of this twisted pair to lug 6 of tube socket V3 (S-1).
- () R12. Connect a 1 megohm (brown-black-green) 1/2 watt resistor from lug 2 (S-1) to lug 4 (NS) of tube socket V3.
- () Connect the remaining free wire coming through grommet H to lug 4 of tube socket V3 (S-2). The other end of this wire is connected to lug 5 of terminal strip F.
- () C4. Connect the .5 μ f tubular capacitor from lug 3 of tube socket V3 (S-2) to lug 1 of terminal strip K (S-1). The lead from the banded end of this capacitor goes to terminal strip K.
- () Connect an 8-3/4" wire from lug 2 of control Q (S-1) to lug 2 of terminal strip K (S-2). Position this wire under the harness wires going to switch P and around the 2 μ f capacitor. See Pictorial 8.
- () Connect a 4-1/2" wire from lug 3 of control Q (S-1) to solder lug V (NS). Position as shown.
- () Insert one end of a 1-1/2" wire through grommet A. Connect the other end to solder lug BB (S-1).
- () Insert one end of a 2-1/4" wire through grommet A. Connect the other end to solder lug AA (S-1). The other ends of the two wires just installed will be connected later.
- () Connect a 2-1/4" wire from lug 2 of switch T (S-1) to lug 1 of fuse holder M (S-1).
- () Connect a 2-1/4" wire from lug 2 of fuse holder M (S-1) to lug 1 of terminal strip J (NS).
- () C10. Connect a .001 μ f disc capacitor from lug 3 (NS) to lug 2 (NS) of terminal strip J.
- () C9. In the same manner, connect the remaining .001 μ f disc capacitor from lug 1 (NS) to lug 2 (S-2) of terminal strip J.
- () Install the line cord and line cord strain relief in chassis hole Z. See Detail 8A. The line cord leads should extend about 1" inside the chassis.



Detail 8A

- () Connect either line cord lead to lug 1 (S-3) and the other lead to lug 3 (NS) of terminal strip J.

Referring to Pictorial 8, connect the following excess wires from breakout #6 to Type switch R. Position the wires as shown:

WIRE COLOR	LUG NUMBER
() Violet	1 (NS).
() Red-white	3 (NS).
() Orange-white	4 (NS).
() White	5 (NS).
() Yellow	6 (NS).
() Blue	8 (S-1).

() Now position the harness away from the movable contact of switch R.

() Connect the hookup wire coming from hole E to lug 7 of switch R (NS).

() R35. Connect a 47 K Ω (yellow-violet-orange) 1/2 watt resistor from lug 6 (S-2) to lug 7 (S-2) of switch R.

() R38. Connect a 10 K Ω (brown-black-orange) 1/2 watt resistor from lug 2 (NS) to lug 5 (S-2) of switch R. Position as shown.

() R11. Connect a 100 Ω (brown-black-brown) 1/2 watt resistor from lug 3 (S-2) to lug 4 (S-2) of switch R.

() R37. Connect an 18 K Ω (brown-gray-orange) 1/2 watt resistor from lug 1 (S-2) to lug 2 (S-2) of switch R.

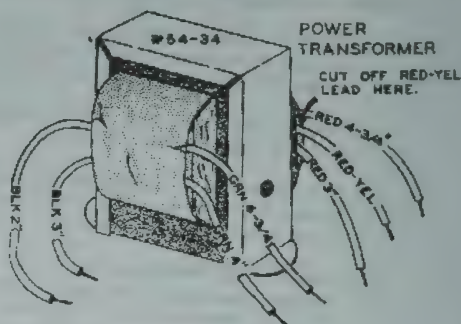
() Connect the green-white wire from breakout #3 to solder lug W (S-1).

() Connect the blue-white wire from breakout #3 to solder lug V (S-2).

() Cut the power transformer (#54-34) leads to the lengths shown in Detail 8B. Strip 1/4" insulation from each lead end and tin.

() Mount the power transformer in the position shown in Pictorial 8. Use two 8-32 screws, a #8 lockwasher, a #8 solder lug, and 8-32 nuts as shown in Detail 8C. The solder lug should be mounted at SS, on the mounting screw nearest tube socket V1. See Pictorial

10. Both green leads go into grommet B and both red leads go into grommet C. They will be connected later.

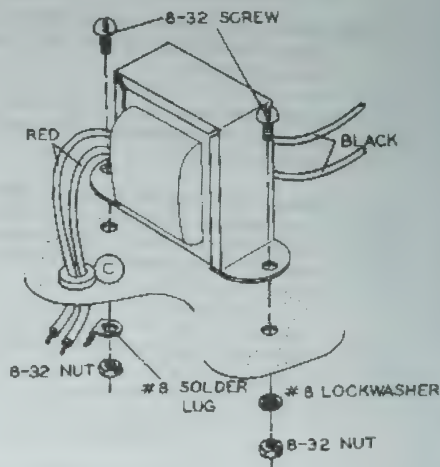


Detail 8B

CAUTION: If necessary, bend lug 2 of fuse holder M away from the transformer frame to prevent shorting the AC line voltage to the chassis.

() Connect the shorter black lead to lug 1 of switch T (S-1).

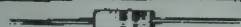
() Connect the remaining black lead to lug 3 of terminal strip J (S-3).



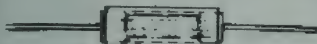
Detail 8C

RESISTORS-CAPACITORS

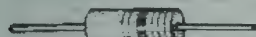
CONTROLS-SWITCHES



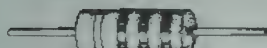
1/2 WATT RESISTOR



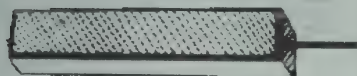
1/2 WATT 1% PRECISION RESISTOR



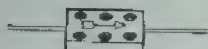
1 WATT RESISTOR



2 WATT RESISTOR



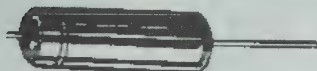
#3J-7
10 KOH 10 WATT WIRE-WOUND RESISTOR



#20-2
200 pf MOLDED MICA CAPACITOR



#21-81
21 DISC CERAMIC CAPACITOR



TUBULAR CAPACITOR



#25-41
50 VOLT ELECTROLYTIC CAPACITOR



#11-40
CONTROL, PRE-WOUND



SLIDE SWITCH

CONNECTORS TERMINAL STRIPS



#427-3
BINDING POST BASE



#431-11
5-LUG TERMINAL STRIP

HARDWARE-INSULATOR



#250-2
3/16" SCREW



#250-18
3/8" SCREW



#250-26
3/8" SCREW



#252-1
3-48 NUT



#252-3
6-32 NUT



#252-4
8-32 NUT



#252-7
CONTROL NUT



#252-22
SPEEDNUT



#254-7
#3 LOCKWASHER



#254-4
CONTROL LOCKWASHER



#255-1
1/8" SPACER



#259-1
#6 SOLDER LUG



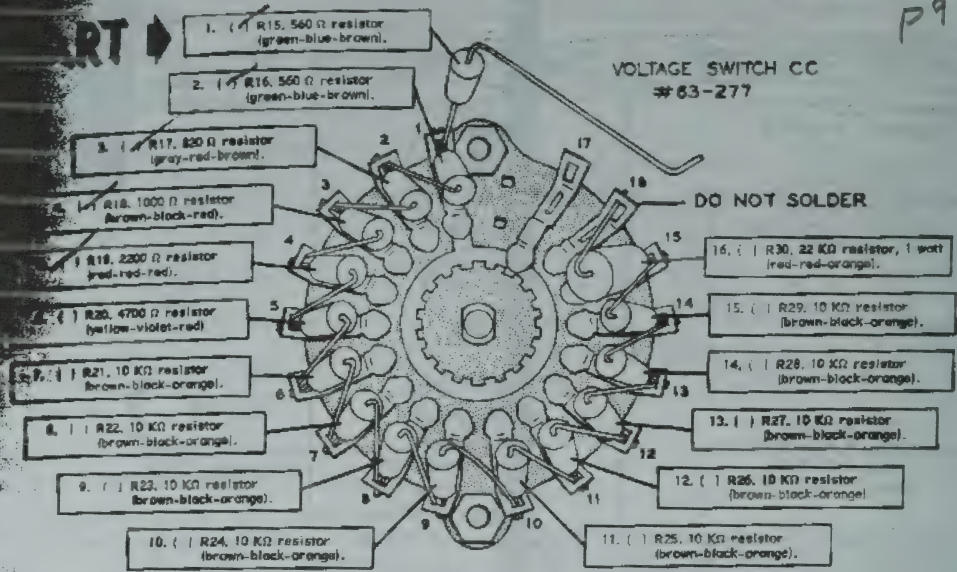
#75-17
BINDING POST INSULATOR

STEP-BY-STEP ASSEMBLY

P9

RT

VOLTAGE SWITCH CC
#63-277



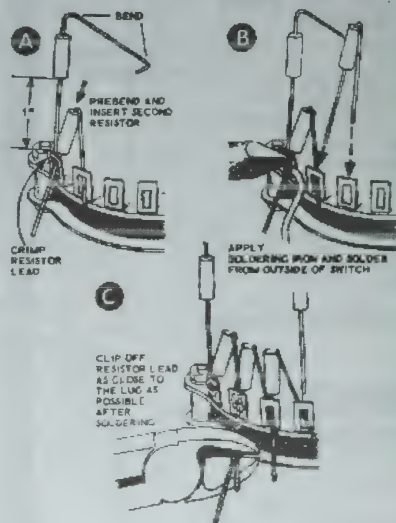
Pictorial 1

VOLTAGE SWITCH CC WIRING

To install a resistor on VOLTAGE switch CC, bend one lead against the resistor body before making the connection. Cut off the excess lead after the connection has been soldered. See Detail 1A.

Perform the steps on Pictorial 1. All resistors are 1/2 watt except R30, which is a 1 watt resistor.

After completing the steps on Pictorial 1, check to be sure all connections except lugs 16 and 17 are soldered. Set this switch aside to be installed later.



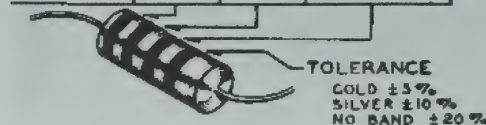
Detail 1A

RESISTOR AND CAPACITOR COLOR CODES

RESISTORS

Colored bands around the body of a color coded resistor represent its value in ohms. These colored bands are grouped around one end of the resistor body. Starting with this end the resistor, the first band represents the first digit of resistance value; the second band represents the second digit; the third band represents the number by which the first two digits are multiplied. A fourth band of gold or silver represents a tolerance of $\pm 5\%$ or $\pm 10\%$ respectively. The absence of a fourth band indicates a tolerance of $\pm 20\%$.

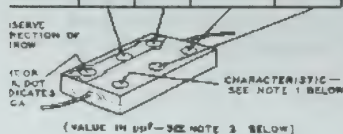
COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER
BLACK	0	0	1
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
VIOLET	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	1,000,000,000
GOLD	-	-	.1
SILVER	-	-	.01



CAPACITORS

Generally, only mica and tubular ceramic capacitors, used in modern equipment, are color coded. The color codes differ somewhat among capacitor manufacturers, however the codes

COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER	TOLER. %
BLACK	0	0	1	±20
BROWN	1	1	10	±10
RED	2	2	100	±5
ORANGE	3	3	1,000	±5
YELLOW	4	4	10,000	±5
GREEN	5	5	—	—
BLUE	6	6	—	—
VIOLET	7	7	—	—
GRAY	8	8	—	—
WHITE	9	9	—	—
GOLD	-	-	.1	±10
SILVER	-	-	.01	±10

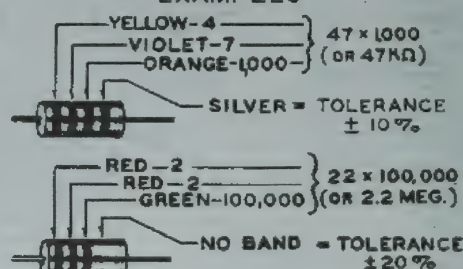


2700µF ±5%
OR .0027µF

The physical size of a composition resistor is related to its wattage rating. Size increases progressively as the wattage rating is increased. The diameters of 1/8 watt, 1 watt and 2 watt resistors are approximately 1/8", 1/4" and 5/16", respectively.

The color code chart and examples which follow provide the information required to identify color coded resistors.

EXAMPLES

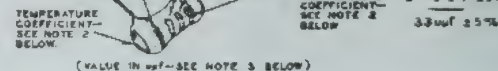


shown below apply to practically all of the mica and tubular ceramic capacitors that are in common use. These codes comply with EIA (Electronic Industries Association) Standards.

TUBULAR CERAMIC

Place the group of rings or dots to the left and read from left to right.

COLOR	1ST DIGIT	2ND DIGIT	MULTIPLIER	TOLER. %	EXAMPLE
BLACK	0	0	1	±20	100
BROWN	1	1	10	±10	100
RED	2	2	100	±5	220
ORANGE	3	3	1,000	±5	3300
YELLOW	4	4	10,000	±5	47000
GREEN	5	5	—	—	—
BLUE	6	6	—	—	—
VIOLET	7	7	—	—	—
GRAY	8	8	—	—	—
WHITE	9	9	—	—	—



NOTES:

expressed in parts per million per degree centigrade. Refer to EIA Standard, RS-198 (a Standard of Electronic Industries Association.)

3. The farad is the basic unit of capacitance, however capacitor values are generally expressed in terms of µF (microfarad, .000001 farad) and µµF (micro-micro-farad, .000001 µF); therefore, 1,000 µµF = .001 µF, 1,000,000 µµF = 1µF.

USING A PLASTIC NUT STARTER

A plastic nut starter offers a convenient method of starting the most used sizes: 3/16" and 1/4" (8 and 3-32). When the correct end is pushed over a nut, the pliable tool conforms to the shape of the nut and the nut is gently held while it is being picked up and started on the screw. The tool should only be used to start the nut.

6-32

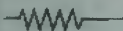


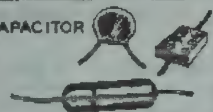
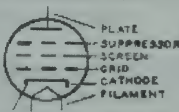

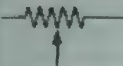
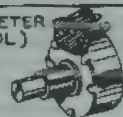
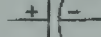





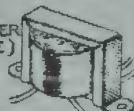






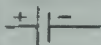



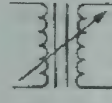

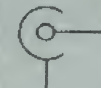


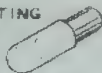
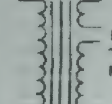









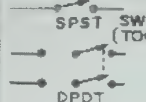






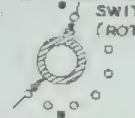


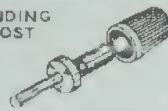










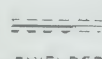


3-48

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations

tions should prove helpful in identifying most parts and reading the schematic diagrams.

RESISTOR  	CAPACITOR  	 TUBE PLATE SUPPRESSOR SCREEN GRID CATHODE FILAMENT 
POTENTIOMETER (CONTROL)  	ELECTROLYTIC CAPACITOR  	PNP TRANSISTOR  EMITTER COLLECTOR NPN TRANSISTOR  EMITTER COLLECTOR 
TRANSFORMER (IRON CORE)  	VARIABLE CAPACITOR  	RECTIFIER (DIODE)  
TRANSFORMER (ADJUSTABLE POWDERED IRON CORE)  	BATTERY  	 NEON BULB 
TRANSFORMER (ADJUSTABLE CORE)  	PHONO JACK  	 ILLUMINATING BULB 
POWER TRANSFORMER  	PHONE JACK  	 METER 
INDUCTOR (COIL)  	RECEPTACLE  	SPST SWITCH (TOGGLE)  DPDT  
PIEZOELECTRIC CRYSTAL  	SPEAKER  	SWITCH (ROTARY)  
BINDING POST  	MICROPHONE  	FUSE  
ANTENNA GENERAL  LOOP 	EARTH GROUND  CHASSIS GROUND 	CONDUCTORS NOT CONNECTED  CONNECTED  SHIELDED 

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information.

- A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.
- B. Identify the type and model number of kit in which it is used.
- C. Mention date of purchase.
- D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. **PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO.** Do not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

In the event that your instrument must be returned for service, these instructions should be carefully followed.

ATTACH A TAG TO THE EQUIPMENT BEARING YOUR NAME, COMPLETE ADDRESS, DATE OF PURCHASE, AND A BRIEF DESCRIPTION OF THE DIFFICULTY ENCOUNTERED. Wrap the equipment in heavy paper, exercising care to prevent damage. Place the wrapped equipment in a stout carton of such size that at least three inches of shredded paper, excelsior, or other resilient packing material can be placed between all sides of the wrapped equipment and the carton. Close and seal the carton with gummed paper tape, or alternately, tie securely with stout cord. Clearly print the address on the carton as follows:

To: HEATH COMPANY
Benton Harbor, Michigan

Include your name and return address on the outside of the carton. Preferably affix one or more "Fragile" or "Handle With Care" labels to the carton, or otherwise so mark with a crayon of bright color. Ship by parcel post or prepaid express; note that a carrier cannot be held responsible for damage in transit if, in HIS OPINION, the article is inadequately packed for shipment.



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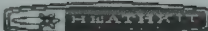
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3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case Of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.
4. Identify the kit model number and date of purchase, if available.
5. Print or type your name and address, preferably in two places on the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like it to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was shipped to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be shipped to you, subject to the terms of the Warranty.

The Factory Service facilities are also available to you, in case you are not familiar enough with electronics to provide our consultants with sufficient information on which to base a diagnosis of your difficulty, or in the event that you prefer to have the difficulty corrected in this manner. You may return the completed instrument to the Heath Company for inspection and necessary repairs and adjustments. You will be charged a minimal service fee, plus the price of any additional parts or material required. However, if the completed kit is returned within the Warranty period, parts charges will be governed by the terms of the Warranty. State the date of purchase, if possible.

Local Service by Authorized HEATHKIT Service Centers is also available in some areas and often will be your fastest, most efficient method of obtaining service for your HEATHKIT equipment. Although you may find charges for local service somewhat higher than for factory service, the amount of increase is usually offset

by the transportation charge you would pay if you elected to return your kit to the Heath Company.

HEATHKIT Service Centers will honor the regular 90 day HEATHKIT Parts Warranty on all kits, whether purchased through a dealer or directly from Heath Company; however, it will be necessary that you verify the purchase date of your kit.

Under the conditions specified in the Warranty, replacement parts are supplied without charge; however, if the Service Center assists you in locating a defective part (or parts) in your kit, or installs a replacement part for you, you may be charged for this service.

HEATHKIT equipment purchased locally and returned to Heath Company for service must be accompanied by your copy of the dated sales receipt from your authorized HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Warranty.

THIS SERVICE POLICY APPLIES ONLY TO COMPLETED EQUIPMENT CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Equipment that has been modified in design will not be accepted for repair. If there is evidence of acid core solder or paste fluxes, the equipment will be returned NOT repaired.

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than the Heath Company.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.
2. It is interesting to note that about 90% of the kits that are returned for repair, do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Proper Soldering Techniques section of this manual.
3. Make sure that all tubes light up properly.
4. Check the tubes with a tube tester or by substitution of tubes of the same types and known to be good.
5. Check the values of the component parts. Be sure that the proper part has been wired into the circuit, as shown in the pictorial diagrams and as called out in the wiring instructions.
6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring beneath the chassis.
7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those found on the Schematic Diagram. NOTE: All voltage readings were taken with a HEATHKIT Vacuum Tube Voltmeter. Voltages may vary as much as 10% due to line voltage variations.
8. A review of the Circuit Description will prove helpful in indicating where to look for trouble.

SERVICE INFORMATION

SERVICE

If, after applying the information contained in this manual and your best efforts, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which the Heath Company makes available to its customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment. It is not intended, and is not equipped to function as a general source of technical information involving kit modifications nor anything other than the normal and specified performance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. In a sense, YOU MUST QUALIFY for GOOD technical advice by helping the consultants to help you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case Of Difficulty. Possibly it will not be necessary to write.
2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.

is provided. The external standard inductance should have characteristics similar to those of the inductance being measured. Multiply for pointer readings on the left side of the scale and divide for readings on the right side of the scale.

MEASURING TRANSFORMER TURNS RATIO

Connect either pair of leads (primary or secondary) to the TEST terminals and the other pair to the EXT. STD. terminals. (Interchanging the primary and secondary leads only results in reading the ratio on the other side of the scale.) Set the RANGE switch to EXT. STD. and adjust the Balance control for eye tube opening. Read the TURNS RATIO directly on the EXTERNAL STANDARD scale.

Polarity is important when measuring turns ratio, due to transformer action. That is, a signal appearing in one winding will also appear in the other winding. If eye tube opening cannot be obtained, reverse the leads of one winding.

In some cases, the ratio may be misleading. This is due to the non-loaded condition of the transformer under test. For example, the fila-

ment winding of a transformer might show up as something other than 18:1. Assuming the primary winding is 117 volts and the filament winding is 6.3 volts, the turns ratio is equal to the primary voltage (117 volts) divided by the secondary filament winding voltage (6.3 volts), which is approximately equal to 18:1.

EXT. GEN.

An external generator may be used for checking components at frequencies other than internal 60 cps. Any audio generator capable of delivering 2 volts or more to the EXT. GEN. terminals at the desired frequency may be used. A larger signal voltage will give a sharper null indication on the eye tube.

The maximum voltage that should be applied to the EXT. GEN. terminals is 6 volts. The frequency limit of this circuit is 10,000 cps.

A point to remember, when using this instrument, is that the greatest error will occur at the ends of the scales, therefore, for greatest accuracy, use the range that will give a null indication on the eye tube nearest center scale.

volts are to be used for miniature electrolytics only), which is usually printed on the capacitor itself. Push the BRIDGE-LEAKAGE switch to the LEAKAGE position and observe the action of the eye tube. A sudden closing and then return to normal shadow angle indicates a satisfactory capacitor. A partially closed eye or fluttering condition would indicate an intermittent condition. If the eye stays closed the capacitor is leaky.

NOTE: The eye may not open on some electrolytics, especially large electrolytics. This does not always mean the capacitor is shorted. Refer to the Capacitor Current section which follows.

After the leakage test, release the BRIDGE-LEAKAGE switch and it will return to the DISCHARGE position. When the eye tube opens, the capacitor under test is discharged and safe to handle.

CAPACITOR CURRENT

The eye will close when approximately 2 milliamperes of direct current are drawn through the test circuit when checking electrolytic capacitors. Approximately 15 microamperes of current are required to close the eye when checking miniature electrolytics, and approximately 2 microamperes are required when checking paper, mica, etc., capacitors.

Some electrolytic capacitors may allow 2 milliamperes of current to go through them and still be satisfactory. In this case, the eye will not open, showing the capacitor to be leaky or shorted. Leakage current is calculated with the following formula: $I = K \pi C + .3$

I = milliamperes of maximum current through the capacitor.

C = capacitance in μfd .

K = constant relative to the voltage rating of the capacitor, as follows:

3 to 100 volts	$K = .01$
101 to 250 volts	$K = .02$
251 to 350 volts	$K = .025$
351 to 450 volts	$K = .04$

EXAMPLE: 40 μfd capacitor rated at 450 volts.

$$I = K \times C + .3$$

$$I = .04 \times 40 + .3$$

$$I = 1.6 + .3$$

$$I = 1.9 \text{ milliamperes.}$$

EXTERNAL STANDARD SCALES

Connect a component of known value to the EXT. STD. terminals. If the component to be tested is a resistor, then the EXT. STD. component must be a resistor; for checking capacitors, the EXT. STD. component must be a capacitor, etc; for checking inductance, use a coil of known value as the external standard. Set the RANGE switch to EXT. STD. and the BRIDGE-LEAKAGE switch to BRIDGE. Adjust the Balance control for eye tube opening. When measuring resistance or inductance and the pointer is on the left side of the scale, multiply the value of the EXT. STD. component by the pointer reading on the EXT. STD. scale. If the pointer is on the right side of the scale, divide the EXT. STD. component by the pointer reading.

When measuring capacitance, divide the value of the EXT. STD. component by the pointer reading when the pointer is on the left side; multiply the value of the EXT. STD. component by the dial reading when the pointer is on the right side.

To improve accuracy when checking small capacitance values, connect a generator to the EXT. GEN. terminals and push the GEN. switch to the EXT. position. Set the generator at 1000 cps and set the RANGE switch to EXT. STD. Balance the bridge for eye tube opening indication. If the pointer does not read "1" (center of scale), add capacitance to the appropriate terminals (TEST or EXT. STD.) until the pointer is at center scale with the bridge balanced. This capacitance should be left on the terminals when checking small value capacitances on the EXT. STD. scale.

NOTE: When measuring inductance, an external standard must be used as no internal inductance

OPERATION

FRONT PANEL

Pictorial 12 (on Page 21) explains the eye tube, and front panel controls and terminals.

NOTE: It is always best to connect the component under test directly to the TEST terminals. Long test leads may pick up stray AC fields and give inaccurate readings. If test leads must be used, keep them as short as possible.

RESISTANCE MEASUREMENT

Connect the unknown resistance to the TEST terminals. Set the RANGE switch to one of the "R" multipliers. The GEN. switch should always be in INT. position on all tests unless an external generator is used. The Type, VOLTAGE, and POWER FACTOR controls are not used in this test. Set the BRIDGE-LEAKAGE switch to the BRIDGE position. Adjust the Balance control for eye tube opening. Read the resistance indicated by the Balance control pointer on the "R" scale and multiply by the RANGE switch setting.

CAPACITANCE MEASUREMENT (lower ranges—X .0001 and X .01).

Connect the unknown capacity to the TEST terminals. The VOLTAGE switch is not used in this test.

Set the Type switch to its lower position, this position is for paper, mica, ceramic, glass, and any other small value capacitors. The RANGE switch should be in either the C X.001 or C X.01 position, depending on the size of the capacitance under test. Set the BRIDGE-LEAKAGE switch to the BRIDGE position and adjust the Balance control for eye tube opening. Read the value of the capacitance on the "C" scale and multiply by the RANGE switch setting.

NOTE: To obtain sharper eye tube indications when measuring small capacitance values, connect an external generator to the EXT. GEN. terminals and set the GEN. switch to EXT. position. Set the generator to 1000 cps.

CAPACITANCE MEASUREMENT (high range—X1, Extended Scale).

WHEN CHECKING ELECTROLYTIC CAPACITORS IT IS ESSENTIAL THAT POLARITY BE OBSERVED. The positive (+) lead of the capacitor should be connected to the positive (red) binding post, and the negative (-) lead to the negative (black) binding post of the TEST terminals. The VOLTAGE switch is not used in this test.

Set the Type switch to either the MIN. 'LYTIC or ELECTROLYTIC position, depending on the capacitor under test. **NOTE:** A MIN. 'LYTIC (miniature electrolytic) can be distinguished from an electrolytic by its high capacitance, low working voltage and small physical size. Miniature electrolytics are usually encased in ceramic or plastic and are completely sealed. Adjust the Balance control and the *POWER FACTOR control for the widest opening of the eye tube. Read the capacitance on the "C" scale or EXTENDED scale, depending on the RANGE switch setting. The capacitance is read at so much (%) power factor. For example: 40 μ d at 6% power factor.

*POWER FACTOR is the measure of the energy loss in an imperfect capacitor. In filter applications, a higher power factor decreases the effective capacity so that the effective capacity at 20 PF (POWER FACTOR) is 98% of the measured capacity. At 30% PF, the effective capacity is decreased to 95%. While at 50% PF, the effective capacity is decreased to 87% of the measured capacity.

A significant point of the capacitor test, well worth remembering, is that a capacitor which will not balance on any of the ranges but allows the eye tube to open on the low end of the low range, is an open capacitor. A capacitor which allows the eye to open on the high end of the high range is a shorted capacitor. In either case, there is no reason to carry the test any further.

LEAKAGE TEST

After the capacitor value has been determined, a leakage test for quality can be made. Set the VOLTAGE switch to the voltage rating of the capacitor (the four voltage positions below 25

TEST AND CALIBRATION

TESTING

If any of the following steps do not produce the desired results, turn the instrument OFF and refer to the In Case Of Difficulty section.

Make sure the line cord is plugged into a standard 117 volt outlet. Turn the instrument on by moving the AC slide switch to the ON position. After a few seconds for warmup, the eye tube should have a green glow and the filaments of the 3 tubes should be lit.

Set the controls to the following positions.

<u>CONTROL</u>	<u>POSITION</u>
() BRIDGE-LEAKAGE	BRIDGE
() GEN.	INT.
() Type switch	Any
() VOLTAGE	3
() POWER FACTOR	0
() RANGE	*

*For positions R X1 through C X1, the eye tube should be closed with the Balance control in any position except maximum clockwise. The tube should be open when the Balance control is maximum clockwise. Position the Balance control maximum clockwise and with your finger touch the negative TEST terminal. The eye tube should tend to close when the RANGE switch is in positions R X100 through C X.01.

- () Set the RANGE switch to C EXT. SCALE. In this position, the eye tube should be closed regardless of the Balance control position.
- () Now set the RANGE switch to EXT. STD. In this position, the eye tube should be open regardless of the Balance control position. As before, touching the negative TEST terminal or the red EXT. STD. terminal should close the eye tube.

- () Switch the GEN. switch to EXT. position. The eye tube should remain open regardless of the RANGE switch or Balance control positions.

VOLTAGE TEST

- () Connect a voltmeter (VTVM or 1000 Ω /volt) to the TEST terminals. Set the voltmeter to read high DC+. Set the BRIDGE-LEAKAGE switch in LEAKAGE position and the TYPE switch to ELECTROLYTIC. Now turn the VOLTAGE switch through its 16 positions. The voltmeter reading should be essentially the same as the VOLTAGE switch indications.

CALIBRATION

Connect the remaining 200 Ω 1% precision resistor to the TEST terminals. Set the RANGE switch to R X1 and the BRIDGE-LEAKAGE switch to the BRIDGE position. Set the GEN. switch to INT. Adjust the Balance control very carefully for maximum opening of the eye tube. Loosen the setscrew in the Balance knob and position the Balance pointer straight down, over the "1" at the center of the EXTERNAL STANDARD scale. Now retighten the setscrew. Remove the 200 Ω resistor and save it for occasional calibration checks.

CHECKING FOR MINIMUM HUM

Set the RANGE switch to EXT. STD. position. Check the width of the eye tube indication. Now reverse the line cord plug and again check the width of the eye tube indication. The line cord plug should be left in the position that gives the widest eye tube opening.

With the BRIDGE-LEAKAGE switch in the BRIDGE position, rotate the Balance control for a very narrow opening of the eye tube. Next rotate the eye tube in its mounting clip until the eye tube opening is vertical.

Install the cabinet using two 6-32 x 3/8" screws. The screws are placed through the rear of the cabinet and into the speednuts in the rear chassis flange.

EYE TUBE: Indicates when the bridge is balanced and shows the condition of the capacitor under test.

BALANCE CONTROL: Permits varying two arms of the bridge for balancing purposes.

POWER FACTOR CONTROL: Balances the series resistance of the capacitor under test.

TYPE SWITCH: Sets up the leakage circuit for testing the various types of capacitors.

AC ON-OFF SWITCH: Is used to turn the instrument on or off.

EXT. STD. TERMINALS: Permits connecting an external standard component into the bridge circuit.

EXT. GEN. TERMINALS: Permits powering the bridge with an external generator.

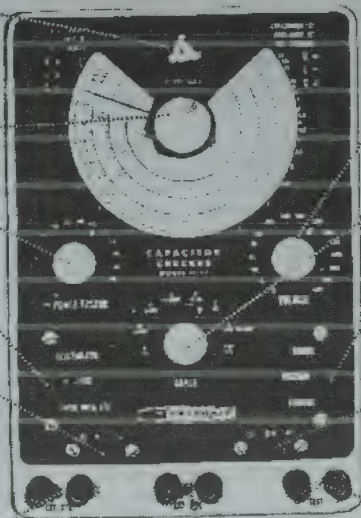
VOLTAGE SWITCH: Selects the proper working voltage when checking capacitor leakage.

RANGE SWITCH: Selects the proper standard for the bridge circuit.

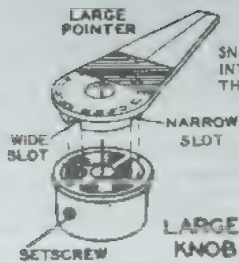
BRIDGE-LEAKAGE SWITCH: Selects desired Test Circuit: BRIDGE DISCHARGE, or LEAKAGE.

GEN. EXT.-INT. SWITCH: Permits selecting the internal generator or an external generator.

TEST TERMINALS: Are used for connecting the component under test to the bridge circuit.



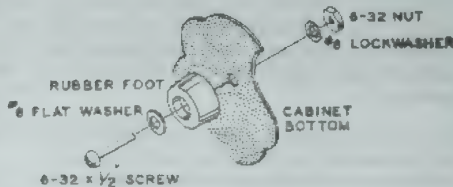
Pictorial 12



Detail 12B

- () Install a knob on each of the two lever switches.
- () Install the six binding post caps in the positions shown in Pictorial 12.
- () Fasten the handle to the cabinet, using two #10 x 1/2" sheet metal screws.

- () Referring to Detail 12C, fasten the rubber feet to the cabinet using four 6-32 x 1/2" screws, #8 flat washers, #6 lockwashers, and 6-32 nuts.



Detail 12C

Set the cabinet aside to be installed later. The only remaining part should be a 200 Ω 1% precision resistor which will be used in calibration.

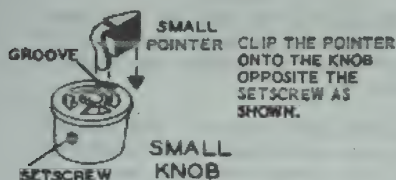
This completes all wiring of the Capacitor Checker. Recheck all connections to see that they are securely soldered. Also, make sure that all wires and components are placed and connected as shown in the illustrations.

FINAL ASSEMBLY

- () Install the 6BN8 and 6AX4 tubes in their proper sockets as shown in Pictorial 11.
- () Slide the eye tube forward until the end of the tube touches the front panel.
- () Install one of the 1/2 ampere slow-blow fuses in the fuse holder.

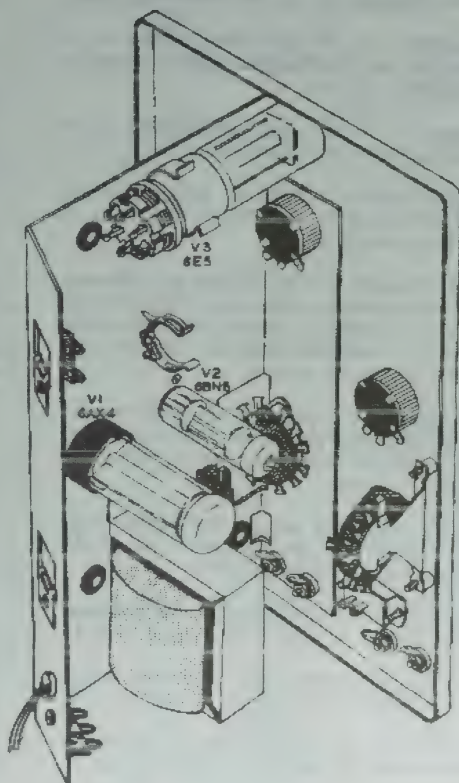
Refer to Pictorial 12 and Details 12A and 12B for the following steps.

- () Prepare each of the three small control knobs by snapping a small pointer onto the knob as shown in Detail 12A.



Detail 12A

- () Install two of these knobs, one on the VOLTAGE switch and one on the RANGE switch. Tighten the setscrew of each knob against the flat side of the switch shaft. It may be necessary to loosen the mounting nut and rotate the switch slightly so the knob pointer will line up with the front panel markings when the knob is rotated.
- () Install the remaining small control knob on the POWER FACTOR control. Position this knob on the control shaft so that the pointer lines up with the front panel markings when the knob is rotated. Now tighten the setscrew.



Pictorial 11

- () Snap the large pointer into the large control knob as shown in Detail 12B. Then install the knob on the Balance control. Turn the control shaft to the center of its range and position the control with the pointer straight down. Now tighten the setscrew in the knob. The pointer should travel an equal distance beyond each end of the scale when the knob is rotated.

Refer to Pictorial 10 for the following steps.

() Connect a 3-1/2" wire from solder lug X (S-1) to lug 11 of switch S (S-1). Position as shown.

() Connect a 1-1/2" wire from solder lug Y (S-1) to lug 16 of switch S (S-1).

() R39. Connect a 6800 Ω (blue-gray-red) 1/2 watt resistor from lug 14 (NS) to lug 15 (S-2) of switch S.

() R36. Connect a 680 Ω (blue-gray-brown) 1/2 watt resistor from lug 14 (S-4) to lug 7 (S-2) of switch S. Solder both lugs. Make sure the resistor leads do not touch any metal part of the switch.

() C5. Connect a .1 μ disc capacitor from lug 13 (S-1) to lug 8 (S-1) of switch S. Make sure the capacitor leads do not touch any other switch contacts.

NOTE: The mounting screws for switch S may now be retightened. Do not pinch any of the wires when tightening the screws.

() Connect the blue-yellow lead from the bridge transformer to lug 2 of switch U (S-1).

() Connect the black lead from the bridge transformer to lug 5 of switch U (S-1).

() Connect the red-yellow lead from the bridge transformer to lug 17 of switch S (S-2).

() Twist together the two green power transformer leads, coming from grommet B, and connect either lead to lug 7 of tube socket V1 (NS).

() Connect the other green lead to lug 8 of tube socket V1 (NS).

() R41. Connect a 100 Ω (brown-black-brown) 1/2 watt resistor from lug 7 of tube socket V1 (S-4) to solder lug SS (NS).

() R42. Connect the remaining 100 Ω (brown-black-brown) 1/2 watt resistor from lug 8 of tube socket V1 (S-4) to solder lug SS (NS).

() Connect the shorter red lead from the power transformer to solder lug SS (NS).

() Connect the remaining red lead from the power transformer to lug 5 of tube socket V1 (S-1).

() Connect a 2" wire between lug 3 of tube socket V2 (S-1) and solder lug SS (S-4).

() R8. Connect a 220 K Ω (red-red-yellow) 1/2 watt resistor from lug 5 of terminal strip F (S-5) to lug 7 of tube socket V2 (S-3). Position as shown in Pictorial 10.

() Connect a 4" wire from lug 8 of tube socket V2 (S-2) to lug 6 of switch S (S-1).

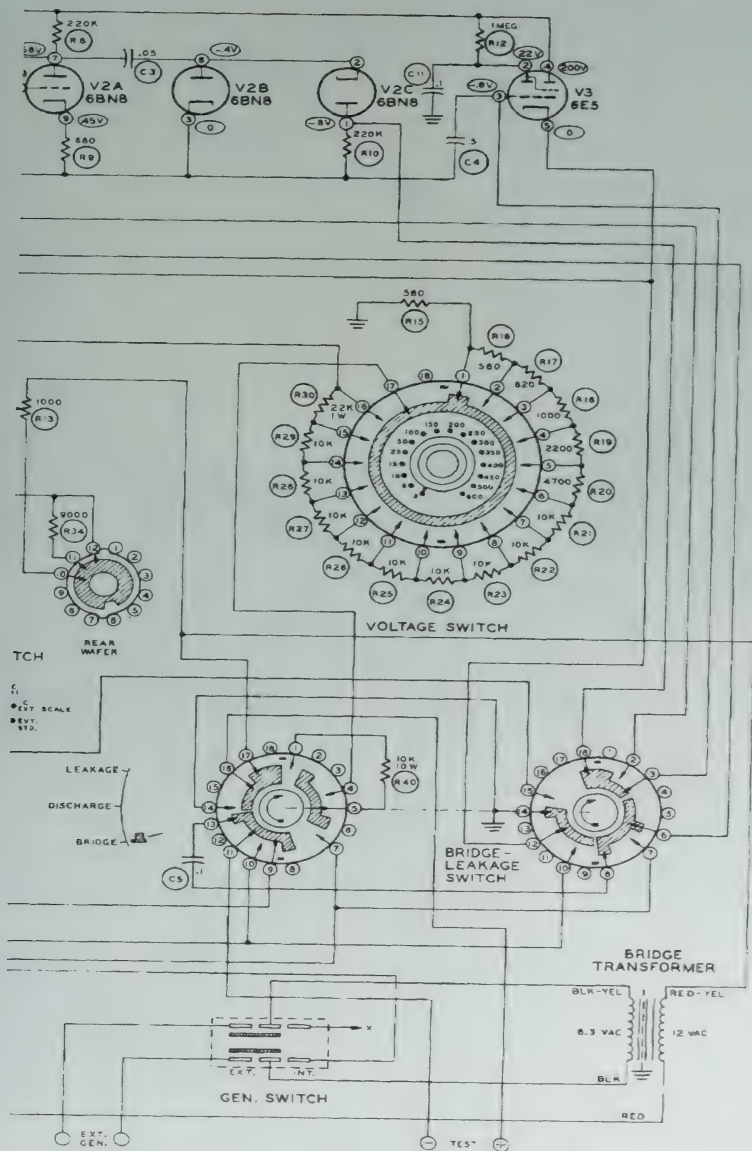
() R40. Connect a 10 K Ω 10 watt wire-wound resistor from lug 1 (S-1) to lug 5 (S-1) of switch S. Position as shown in Pictorial 10.

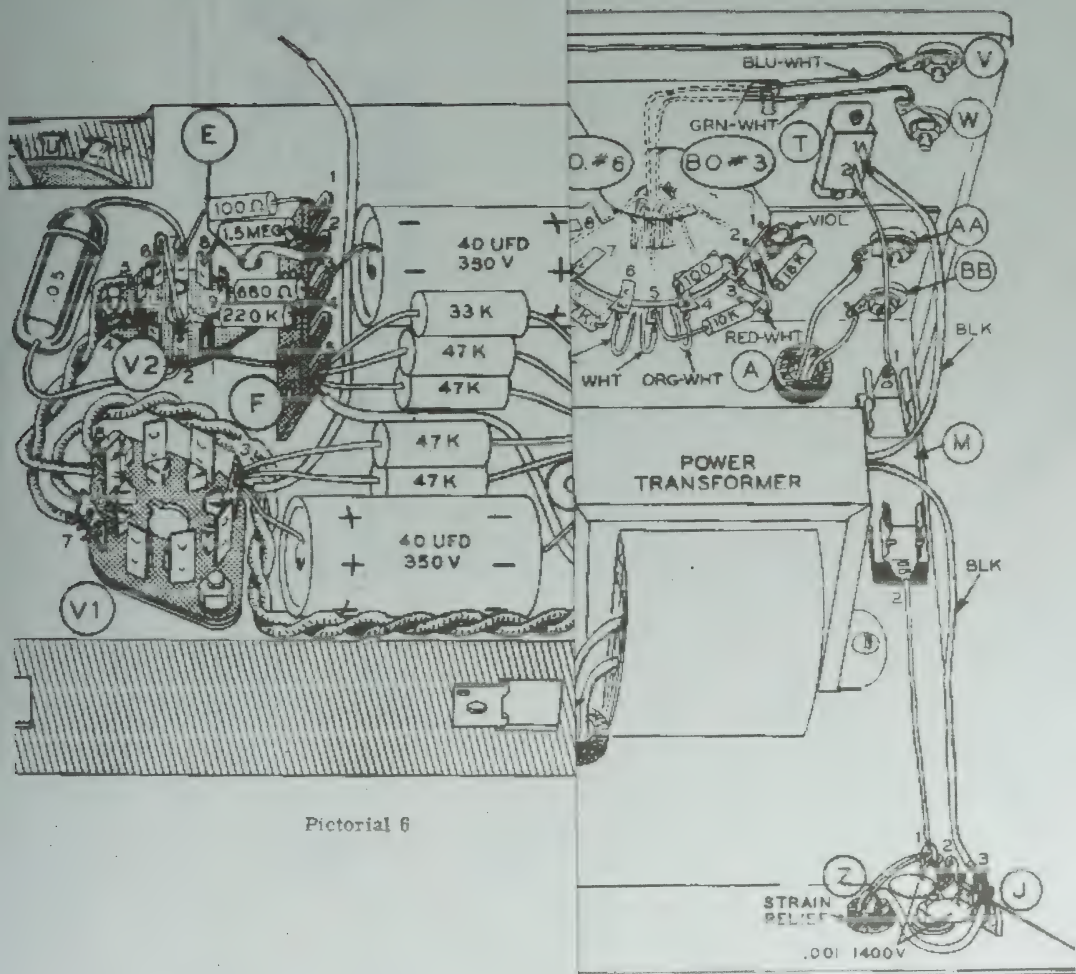
() Locate VOLTAGE switch CC (#63-277) and, using a control lockwasher, flat washer and control nut, mount it with its lugs in the position shown in Pictorial 10. If necessary, bend the resistors of this switch inward to avoid interference with the wiring of tube socket V2.

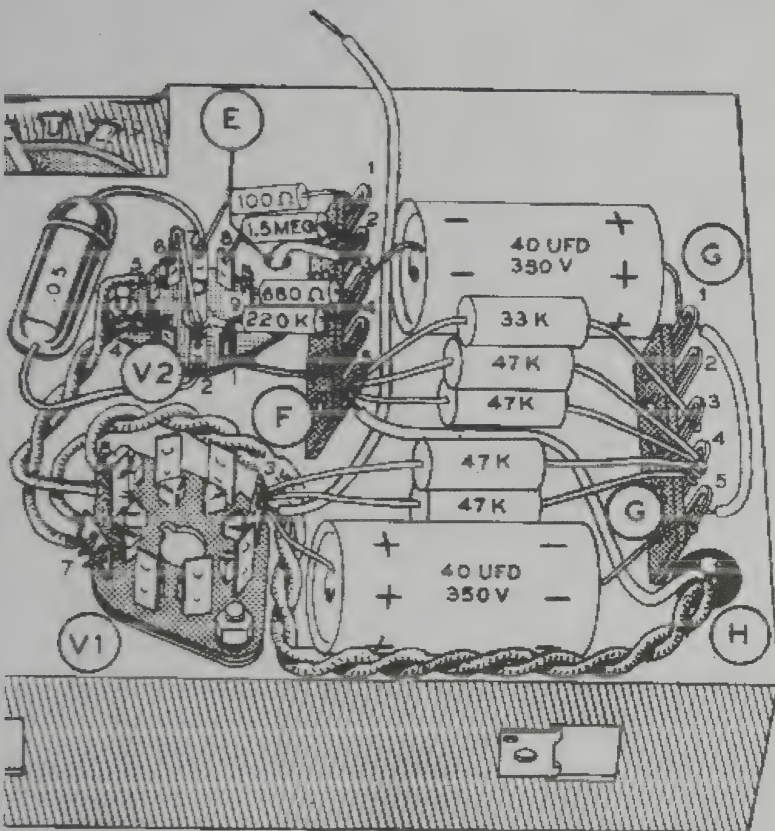
() Connect the wire coming from lug 3 of tube socket V1 to lug 16 of switch CC (S-2).

() Connect the orange wire coming from break-out #5 to lug 17 of switch CC (S-1).

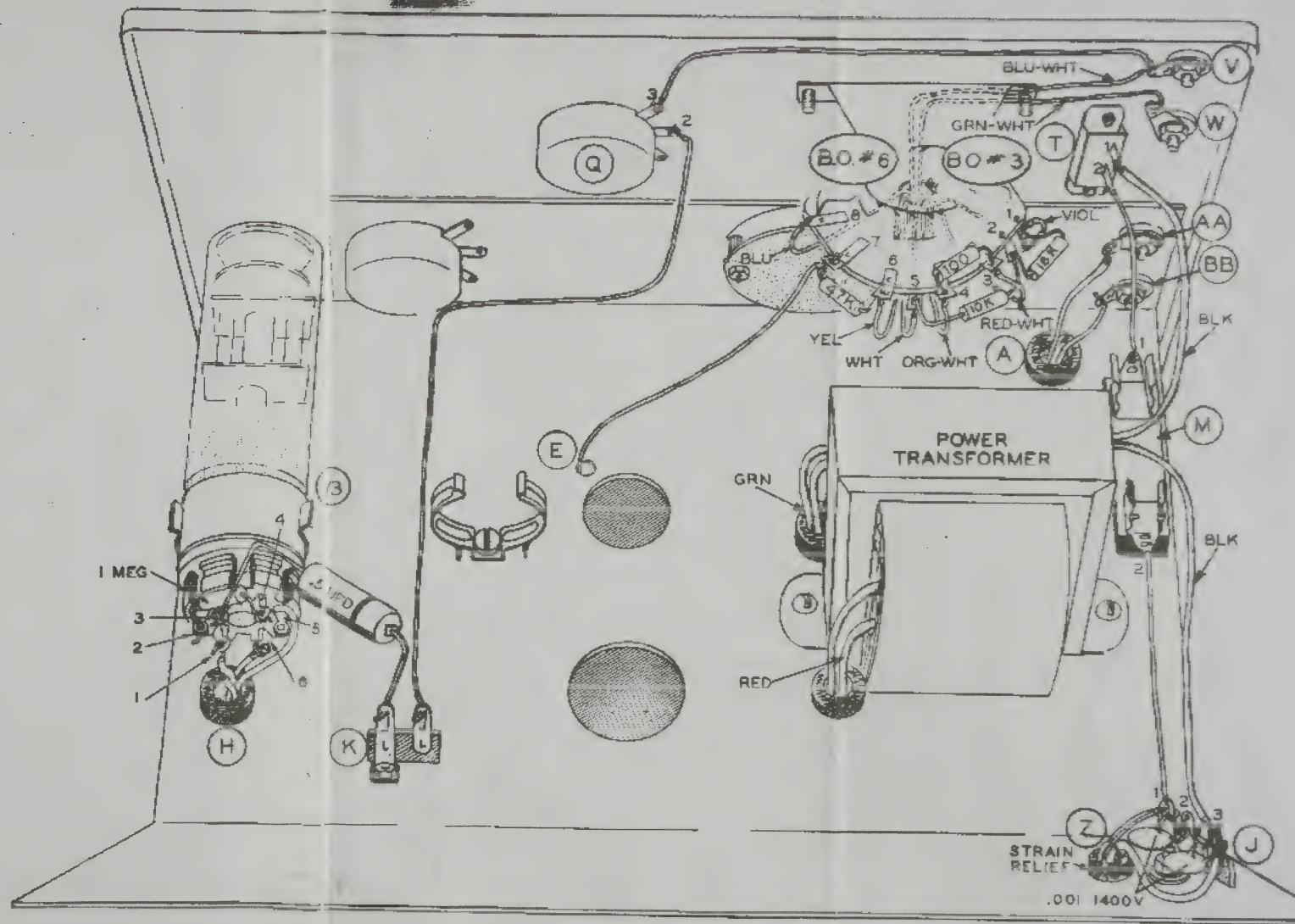
() Connect the free lead of the 560 Ω resistor coming from lug 1 of switch CC to lug 3 of terminal strip F (S-5).



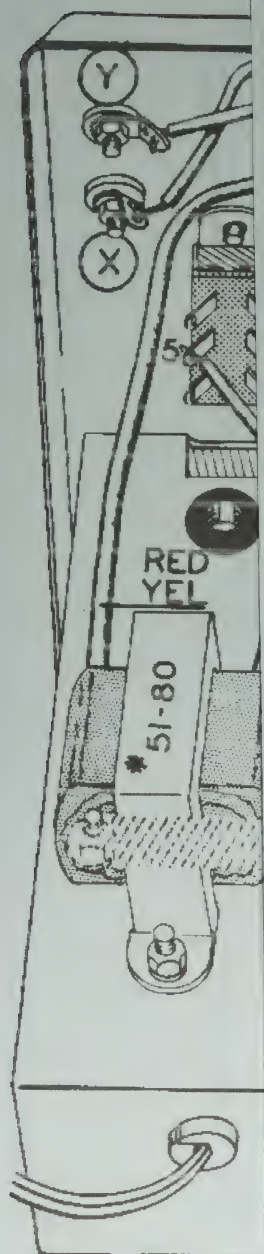




Pictorial 6

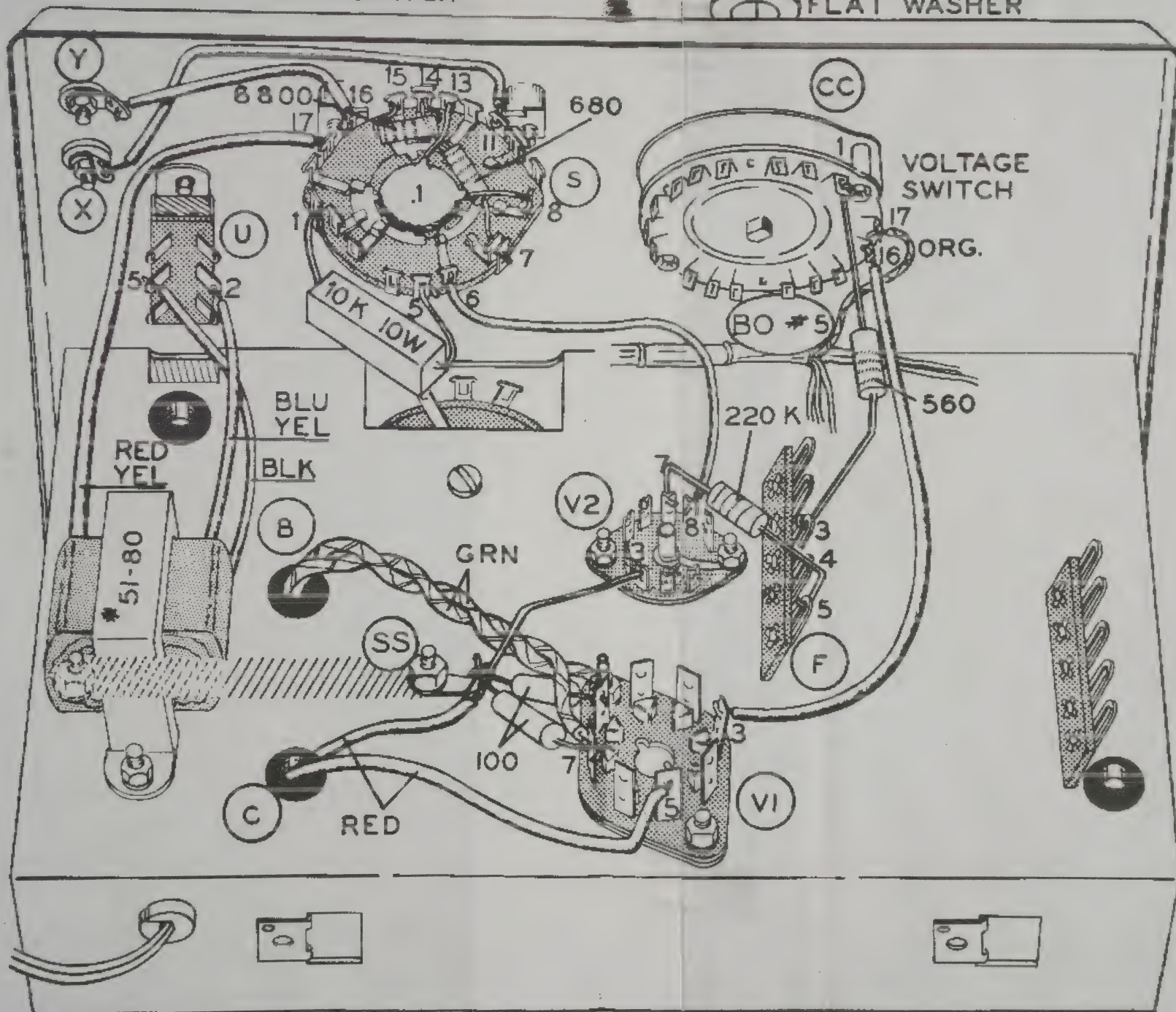


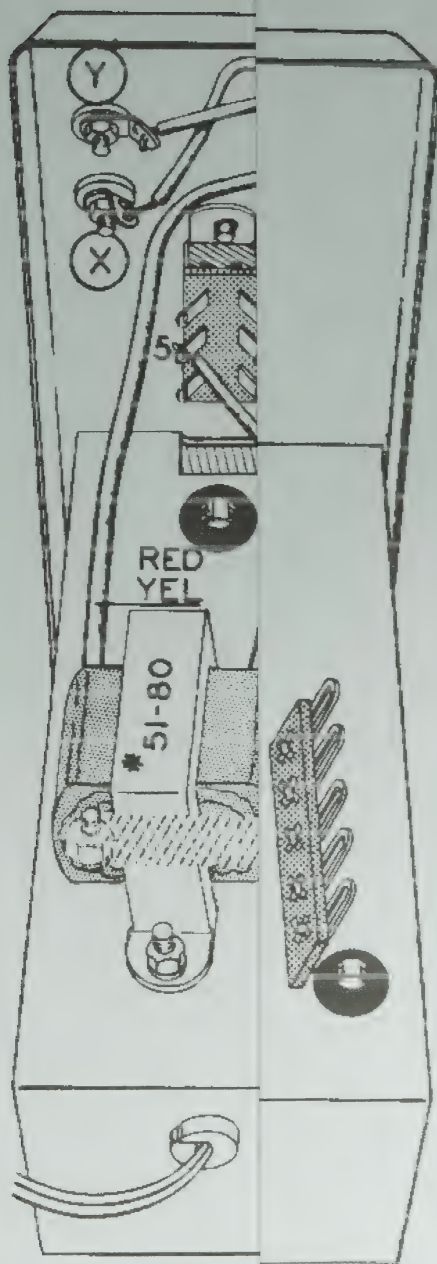
Pictorial 6



BRIDGE LEAKAGE SWITCH

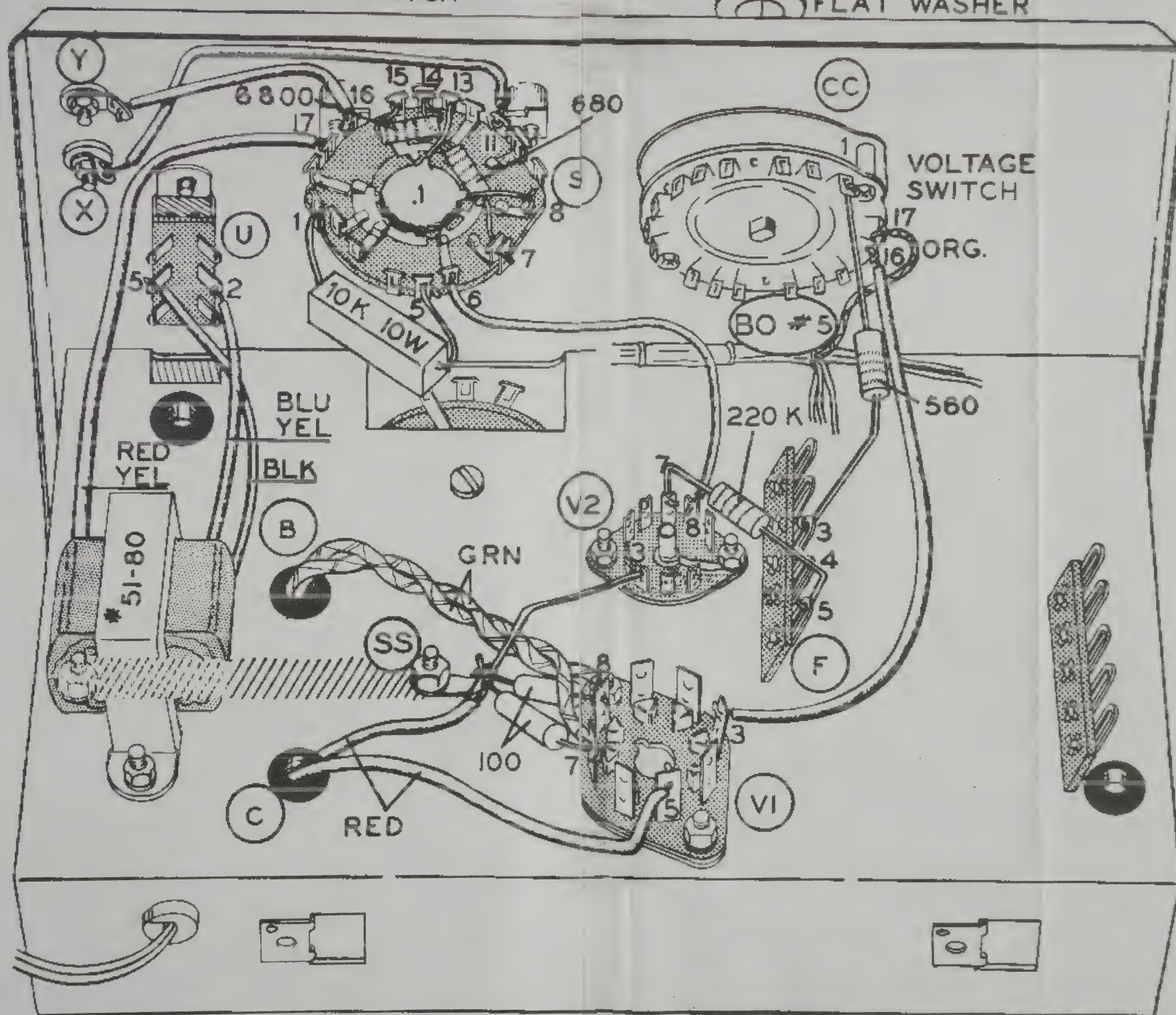
CONTROL NUT
FLAT WASHER







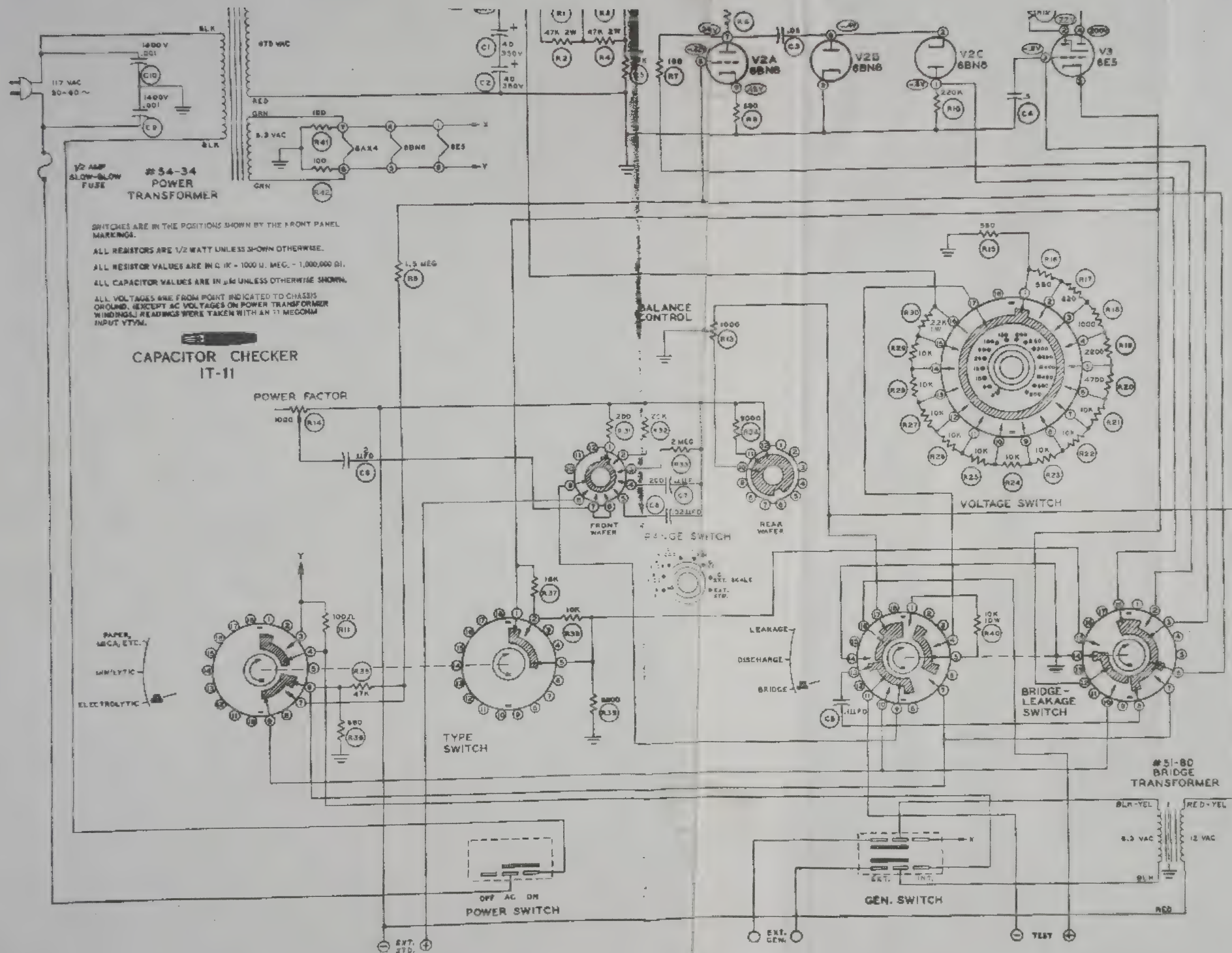
CONTROL NUT
FLAT WASHER





1/2" x
6L2W
Fu

EL DC



PRICE \$1.00



**Assembling
and Using Your...**

Heathkit

**CAPACITOR
CHECKER
MODEL IT-11
CIRCUIT
MODIFICATION
KIT**

HEATH COMPANY

A Subsidiary of Daystrom Inc.

BENTON HARBOR, MICHIGAN



■ HEATH COMPANY

BENTON HARBOR, MICHIGAN YUKON 3-3981

November 10, 1961

Dear Customer:

Your IT-11 Capacitor Checker includes a circuit change to permit calibration of the leakage test circuit. This additional feature is being included at no extra charge to you. To avoid any delay in shipping your kit while printing new manuals to cover the circuit improvement, we have elected to send the current IT-11 Manual with this letter and the enclosed IT-11 Modification Kit instructions. This letter explains how to use the Modification instructions with the IT-11 Manual to incorporate the leakage circuit improvement while assembling the IT-11 Kit. To become familiar with the circuit changes, study the Modification instructions and the remainder of this letter before starting to assemble your Capacitor Checker.

The following changes should be made in the Parts List (Page 7) of the IT-11 Manual:

Resistors

Delete:	1-19	1	6800 Ω 1/2 watt (blue-gray-red)
Change:	1-20	10 to 9	10 K Ω 1/2 watt (brown-black-orange)
Delete:	1-69	1	18 K Ω 1/2 watt (brown-gray-orange)

The following change should be made in the Modification Kit Parts List:

Delete:	204-M476	1	Control bracket
---------	----------	---	-----------------

Make the following changes in the IT-11 Manual:

Page 12 - Under "Chassis Parts Mounting"

Before starting with chassis parts mounting, you should refer to the Modification Kit instructions and mount the three tab-mount, 100 K Ω controls in the location shown. However, the controls will mount on the chassis rather than the bracket.

Page 13 -

In the last step in the right-hand column, change the solder instruction to (NS).

Page 16 -

In step 9 in the right-hand column, change the solder instruction to (NS).

Page 18 -

In step 3 in the left-hand column, change the first solder instruction in the step to (NS).

In step 5 in the left-hand column, change last solder instruction in the step to (NS).

Page 19 -

In step 1 in the left-hand column, change the solder instruction to (S-1).

Delete step 10 of the left-hand column.

Delete step 12 of the left-hand column.

Page 20 -

In step 9 in the right-hand column, change the solder instruction to (S-1).

Page 21 -

Delete step 3 of the left-hand column.

Just before "Final Assembly" in the IT-11 Manual, you should complete all the steps except 1, 2, and 3 on Page 2 in the right-hand column of the Modification Kit instruction sheet.

After completion of the Modification Kit instructions, including Calibration, return to the IT-11 Manual and complete "Final Assembly."

The Schematic Diagram on the next page reflects the circuit changes in your Capacitor Checker.

Thank you,

HEATH COMPANY

MODIFICATION KIT

MODEL IT-11

CAPACITOR CHECKER

The purpose of this Modification Kit is to provide adjustments in the leakage circuit for proper eye tube operation at specified leakage currents. Check the parts against the Parts

List and then proceed with the Modification Instructions. After the modification is completed, use the Calibration Instructions to obtain eye tube closure at the correct leakage currents.

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
204-M476	1	Control bracket
10-58	3	100 K Ω control
1-25	3	47 K Ω resistor (yellow-violet-orange)
1-26	1	100 K Ω resistor (brown-black-yellow)

PART No.	PARTS Per Kit	DESCRIPTION
1-36	1	1.5 megohm resistor (brown-green-green)
23-28	1	.1 μ fd, 200 V tubular capacitor
344-1	1	Length hookup wire

MODIFICATION INSTRUCTIONS

NOTE: Before proceeding, review the Proper Soldering Techniques and Step-By-Step Procedure sections of your IT-11 Manual.

Refer to Figure 1 for the following steps.

- () R43, 44, 45. Mount the three 100 K Ω controls to the control bracket. Secure each control by twisting its mounting tabs 1/8 turn.
- () Loosen the screws holding terminal strip F and the eye tube mounting clip on the IT-11 chassis. Position the new control bracket under the mounting foot of terminal strip F and under the nut for the eye tube clip. The red and violet harness wires should fit in the notch of the control bracket. Then retighten the screws. Refer also to Pictorial 6 in the IT-11 Manual.
- () Bend the control lugs 90 degrees as shown in Figure 1.
- () R39. Clip one lead of a 47 K Ω resistor to 1" and the other lead to 1/2". Pass the 1" lead through lug 1 (NS) to lug 2 (S-1) of control MC. Connect the other lead to lug 3 of MC (NS).
- () R38. Clip both leads of a 47 K Ω resistor to 1". Pass one lead through lug 3 of control MB (NS) to lug 1 of control MC (S-3). Pass the other lead through lug 1 (NS) to lug 2 (S-1) of control MB.

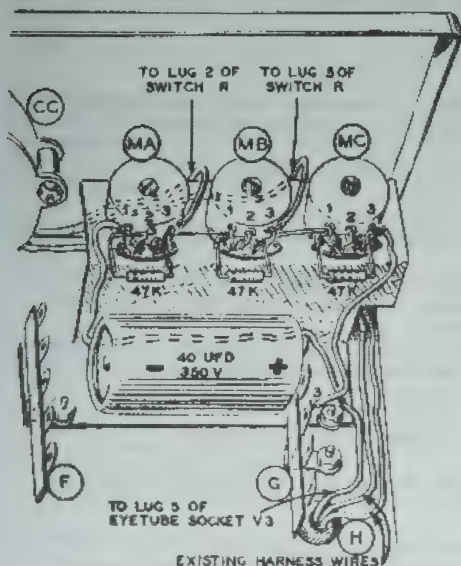


Figure 1

() R37. Clip both leads of the remaining 47 K Ω resistor to 1". Pass one lead through lug 3 of control MA (NS) to lug 1 of control MB (S-3). Pass the other lead through lug 1 (NS) to lug 2 (S-1) of control MA.

() Connect a 4" hookup wire from lug 3 of control MC (S-2) to lug 3 of terminal strip G (S-2).

() Connect one end of a 7-1/2" hookup wire to lug 1 of control MA (S-3). Pass the other end of this wire through grommet H and connect it to lug 5 of eye tube socket V3 (S-2). Refer to Pictorial 4 in the IT-11 manual to identify lug 5 of V3.

() C11. Connect a .1 μ fd tubular capacitor from lug 2 of the eye tube socket V3 (S-2) to lug 1 of terminal strip K (S-2). The banded end of the capacitor goes to terminal strip K. Refer to Pictorial 5 of the IT-11 manual to identify lug 1 of terminal strip K.

NOTE: In the next three steps, cut the resistor leads, rather than unsolder them, to prevent possible damage to the switches.

() Remove the 6800 Ω (blue-gray-red) 1/2 watt resistor connected between lugs 14 and 15 of Bridge-Leakage switch S. Refer to Pictorial 10 of the IT-11 Manual.

() Remove the 18 K Ω (brown-gray-orange) 1/2 watt resistor connected between lugs 1 and 2 of Type switch R. Refer to Pictorial 8 of the IT-11 Manual.

() Remove the 10 K Ω (brown-black-orange) 1/2 watt resistor connected between lugs 2 and 5 of switch R. Refer to Pictorial 8 of the IT-11 Manual.

Refer to Pictorial 8 of the IT-11 and Figure 1 of the Modification Kit sheet for the following steps. Place the leads through the chassis cutout near RANGE switch P.

() Connect an 11" hookup wire from lug 2 of Type switch R (S-1) to lug 3 of control MA (S-3).

() Connect a 12" hookup wire from lug 5 of Type switch R (S-2) to lug 3 of control MB (S-3).

CALIBRATION

There are two calibration procedures which can be used; the first without and the second with a milliamperemeter. The first is quite satisfactory, however, the second procedure will provide greater accuracy.

CALIBRATION WITH NO MILLIAMPERE METER

1. Turn the IT-11 on, and allow it to warm up.

2. Connect a 100 K Ω (brown-black-yellow) resistor across the Test terminals.

3. Set the controls as follows:
Voltage - 300 volts,
Type - Electrolytic.
Bridge-Leakage -- Leakage.

4. Adjust the eye tube to "just closed" with the top (MC) calibrate control.

5. Move the Leakage switch to Discharge and remove the 100 K Ω resistor.

6. Connect a 1.5 megohm (brown-green-green) resistor across the Test terminals.

7. Set the controls as follows:
Voltage - 25 volts,
Type - Min. Lytic.
Bridge-Leakage -- Leakage.

8. Adjust the eye tube to the "just closed" position with the bottom (MA) calibrate control.

9. Set the controls as follows:
Voltage - 3 volts,
Type - Paper,
Bridge-Leakage -- Leakage.

10. Adjust the eye tube to "just closed" position with the center (MB) calibrate control.

11. Return the Leakage switch to Discharge and remove the 1.5 megohm resistor from the Test terminals.

This completes the calibration. Install the IT-11 in the cabinet.

() R37. Clip both leads of the remaining 47 K Ω resistor to 1". Pass one lead through lug 3 of control MA (NS) to lug 1 of control MB (S-3). Pass the other lead through lug 1 (NS) to lug 2 (S-1) of control MA.

() Connect a 4" hookup wire from lug 3 of control MC (S-2) to lug 3 of terminal strip G (S-2).

() Connect one end of a 7-1/2" hookup wire to lug 1 of control MA (S-3). Pass the other end of this wire through grommet H and connect it to lug 5 of eye tube socket V3 (S-2). Refer to Pictorial 4 in the IT-11 manual to identify lug 5 of V3.

() C11. Connect a .1 μ d tubular capacitor from lug 2 of the eye tube socket V3 (S-2) to lug 1 of terminal strip K (S-2). The banded end of the capacitor goes to terminal strip K. Refer to Pictorial 5 of the IT-11 manual to identify lug 1 of terminal strip K.

NOTE: In the next three steps, cut the resistor leads, rather than unsolder them, to prevent possible damage to the switches.

() Remove the 6800 Ω (blue-gray-red) 1/2 watt resistor connected between lugs 14 and 15 of Bridge-Leakage switch S. Refer to Pictorial 10 of the IT-11 Manual.

() Remove the 18 K Ω (brown-gray-orange) 1/2 watt resistor connected between lugs 1 and 2 of Type switch R. Refer to Pictorial 8 of the IT-11 Manual.

() Remove the 10 K Ω (brown-black-orange) 1/2 watt resistor connected between lugs 2 and 5 of switch R. Refer to Pictorial 8 of the IT-11 Manual.

Refer to Pictorial 8 of the IT-11 and Figure 1 of the Modification Kit sheet for the following steps. Place the leads through the chassis cutout near RANGE switch P.

() Connect an 11" hookup wire from lug 2 of Type switch R (S-1) to lug 3 of control MA (S-3).

() Connect a 12" hookup wire from lug 5 of Type switch R (S-2) to lug 3 of control MB (S-3).

CALIBRATION

There are two calibration procedures which can be used; the first without and the second with a milliamperemeter. The first is quite satisfactory, however, the second procedure will provide greater accuracy.

CALIBRATION WITH NO MILLIAMP METER

1. Turn the IT-11 on, and allow it to warm up.

2. Connect a 100 K Ω (brown-black-yellow) resistor across the Test terminals.

3. Set the controls as follows:
Voltage - 300 volts.
Type - Electrolytic.
Bridge-Leakage -- Leakage.

4. Adjust the eye tube to "just closed" with the top (MC) calibrate control.

5. Move the Leakage switch to Discharge and remove the 100 K Ω resistor.

6. Connect a 1.5 megohm (brown-green-green) resistor across the Test terminals.

7. Set the controls as follows:
Voltage - 25 volts.
Type - Min. Lytic.
Bridge-Leakage -- Leakage.

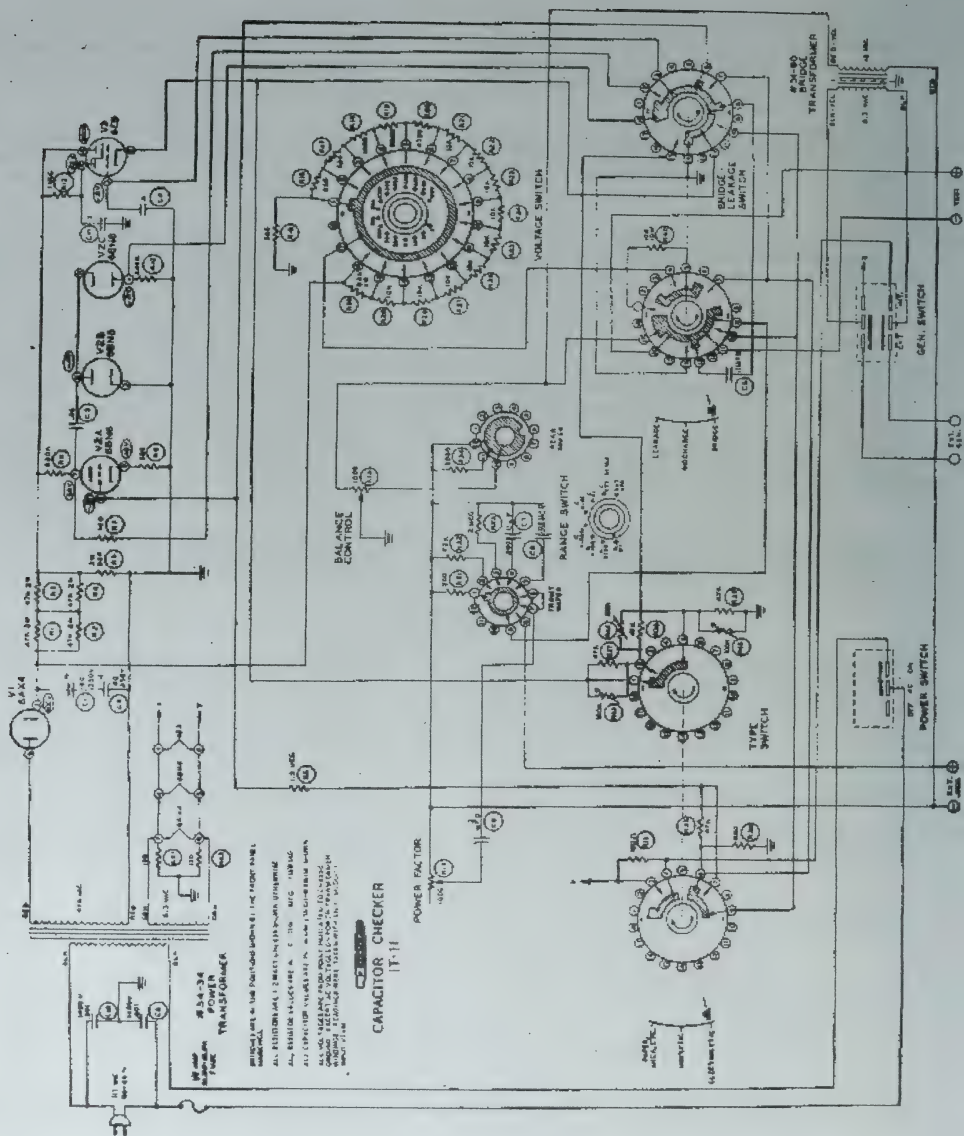
8. Adjust the eye tube to the "just closed" position with the bottom (MA) calibrate control.

9. Set the controls as follows:
Voltage - 3 volts.
Type - Paper.
Bridge-Leakage -- Leakage.

10. Adjust the eye tube to "just closed" position with the center (MB) calibrate control.

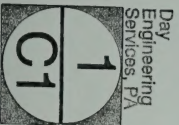
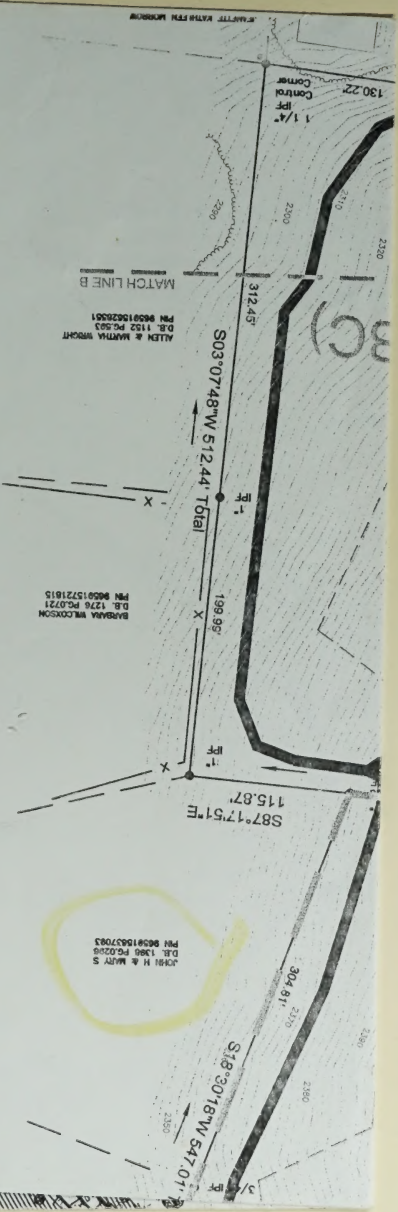
11. Return the Leakage switch to Discharge and remove the 1.5 megohm resistor from the Test terminals.

This completes the calibration. Install the IT-11 in the cabinet.



■ HEATH COMPANY

DAYSTROM, INCORPORATED



SITE PLAN/PRELIMINARY PLAT

1"=100'

FALCON RIDGE

BENTON HARBOR, MICHIGAN YUKON 3-3991

■ HEATH COMPANY

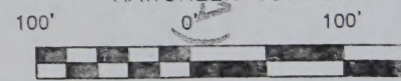
DAYSTROM, INCORPORATED

REVIEW SUPERVISOR

CITY OF ASHEVILLE
BUNCOMBE COUNTY
(COA)
(BC)

PIN 9659

HAWCREEK TOWNSHIP



SCALE

